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SURGERY

ITS PRINCIPLES AND PRACTICE

BY VARIOUS AUTHORS

EDITED BY

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VOLUME VI

With 519 Illustrations, 22 of them in Colors

PHILADELPHIA AND LONDON

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PREFACE TO VOLUME VI

Although the time that has elapsed since the publication of even the first volume in this System of Surgery is not very long, yet the progress of surgery in many departments has been so rapid that some of the earlier matter is obsolete, and there is much new matter which should be placed before the profession in a readily accessible form in any System claiming to be "up to date."

Accordingly, the authors were asked to furnish supplementary matter so as to bring their chapters fully abreast of the present status of surgery. A few new chapters or sections have been introduced, *e. g.*, an important chapter on Anoci-association, a fuller description of apparatus for operating on the thorax and its contents under positive and negative pressure; the method of anesthesia of Meltzer and Auer by intratracheal insufflation; the newer methods of anesthesia by nitrous oxid and by the intravenous introduction of ether; the surgery of the hypophysis; the treatment of cancer by fulguration, desiccation, etc.; the rapidly extending use of iodin as a disinfectant of wounds and of the field of operation; the use of salvarsan in syphilis, etc. The department in which the greatest progress has been made within the last five years has been Thoracic Surgery. This has been fully discussed.

Even since the last manuscript was put in type valuable matter has appeared, but too late to be included in the text.

There have been some subjects which have not been included, as, for example, Meltzer's method of artificial respiration, as they have not distinctly passed from the experimental stage into established methods.

The researches of Wassermann and others on mouse cancer, however, I deemed so important that, though the method was not yet suitable for trial upon human beings, I thought attention ought to be called to the ascertained facts and to the chief sources of information, which the reader could consult at his leisure. Moreover, such important re-

searches might point the way to other similar investigations in other fields by some of our readers which might yield a rich harvest.

In a few cases there has been some repetition, for example, in the use of iodin, the various methods of operating upon the thorax and its contents, etc. I did not deem it unwise to allow such moderate repetitions, because these were such novel subjects or procedures that each author looked at the matter from a different point of view and contributed something to the sum of knowledge.

For various reasons a few of the authors in the first five volumes have been unable to furnish the supplementary matter for their chapters, and others, to whom my sincere thanks are due, have kindly consented to furnish this material.

Besides those noticed in the Postscript in Volume V., the following authors have passed away. Professor John C. Munro, of Boston, regretted by all of his friends, his colleagues, and the community at large, and a great loss to surgery. Lars John Fredrik Zachrisson, Docent in Surgery in the University of Upsala, who died at the early age of forty-three from leukemia. He had replaced his distinguished master Lennander as the author of the chapter on Spinal Anesthesia, and had already given promise of a brilliant career. Surgeon-general Robert M. O'Reilly, U. S. Army (retired), whose admirable services to Military Surgery and the Army Medical Department have been widely recognized. Professor Arthur T. Cabot, of Boston, whose services to the profession, to Harvard University, and to the community are held in loving remembrance by multitudes. And finally my former pupil, assistant, friend, and colleague, Professor Orville Horwitz, whose untimely loss is deplored by the profession, his friends, and his many patients.

The General Index to the whole six volumes, it is believed, will prove very useful. On account of its size it was impossible to append it to Volume V. as I had wished.

I desire to express my sense of obligation to the authors for their painstaking labor, to the profession at large for their kind appreciation of the earlier volumes, and also to the reviewers whose valuable suggestions have been much appreciated. I hope that the sixth volume will be considered a worthy companion to its predecessors. To work with such cordial help as has always been given by the Publishers and their various employees has been a pleasure.

William W. Keen.

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CHAPTER LXXXVII.

INFLAMMATION.[1]

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The advances which have been made in the knowledge of the inflammatory process during the years that have elapsed since the publication of Vol. I., p. 182, in 1905 of necessity have not been uniform all along the line. I must thus select here one series of observations, there another, which, in my opinion, is of material importance. Anything like a continued narrative is, therefore, impossible. What is here set forth must be regarded as notes amplifying the original text. The various matters will be taken up in the order of exposition in that original text.

THE DOCTRINE OF INFLAMMATION.

The debate on what is and what is not inflammation, what to be included in and what excluded from our conception of the process proceeds merrily apace, nor does it seem likely that, until the end of the chapter, or until, following Thoma's quixotic advice, we agree to expunge the term from our vocabulary, there will be absolute agreement. Here we may note three of the more recent contributions to the discussion.

In the chapter he contributes to Aschoff's "Pathologische Anatomie" Lubarsch frankly admits that it is not one process, but a combination of processes, characterized by cell and tissue alteration, escape of cellular and fluid constituents of the blood into the tissues, and tissue growth; only when all three are associated can we speak of inflammation. He points out that vascular disturbances are not primary, and quotes with approval Ribbert's definition that inflammation is the sum of all those processes which, induced by various injuries to the tissues, bring about a direct action of the cells and fluids of the body upon those tissues. Ribbert, however, carries his definition so far that he includes general systemic disturbances the results of injury among the inflammatory phenomena. We wholly agree with Lubarsch that this is neither neces-

[1] Supplementary to Chapter V., Vol. I., p. 182.

sary nor commendable. To include fever, antitoxin formation, proliferation of leukocytes in the bone-marrow, and enlargement of lymph-nodules at a distance among the phenomena of inflammation, is so to expand the term as to include under it the whole subject of general infection. We adhere to the definition that inflammation is the *local* reaction to actual or referred injury. And here it may be noted that Lubarsch, in company with most German writers, wholly overlooks the subject of sympathetic or referred inflammation. The redness, swelling, heat, and pain of the cheek that often accompanies an abscess at the root of a tooth have all the earmarks of a true inflammation, and yet there has been no injury to the tissues of the cheek; it is the nerves of the cheek which sympathetically induce all the changes.

A foremost British pathologist, Professor Muir,[1] takes a somewhat similar, but more negative point of view. Inflammation is not a process, but a complex of processes. Admitting that we cannot, with Cohnheim, regard the vascular disturbances as the essential disturbance, he points out that, following every injury to a part, we recognize (1) retrogressive changes, as indicated by degeneration or necrosis of the cells of the part, and (2) progressive or reactive changes which show themselves in the form of (*a*) increased formative activity (reparative changes) and (*b*) increased functional activity (*e. g.*, active phagocytosis). He holds that the only alternatives are either to select one phenomenon or group of phenomena, and say that this is the essential, or, on the other hand, to make the term all embracing, in which case it becomes devoid of any meaning of value. Neither alternative seems to him likely to be useful. Nothing is to be gained, from a scientific point of view, in attempting to formulate a definition of inflammation which will be precise in its meaning. For his own part, he finds that unconsciously he avoids using the term inflammation: in each case of tissue disorder, that is, he sees or attempts to see the dominant progressive or retrogressive changes. Even in clinical work a like analysis is necessary. There must be a consideration of all the processes that are active in any particular case if a right treatment is to be employed. Thus, the clinician has to enquire into (1) the nature and mode of introduction of the irritant and the damage done by it, (2) the extent of neutralization of the irritant and mode of removal of the same and of the damaged tissue, and (3) the process of repair. How to diminish the first and promote the other two processes constitute the essence of therapeutics.

Now, there is much in these arguments that excites our sympathy. It is difficult if not impossible to give a definition of inflammation which is a true definition, including only that which can reasonably be regarded as coming within the accepted meaning of the term, and, on the other hand, excluding everything that does not come within that accepted meaning. The difficulty in assenting to Professor Muir's advice lies in this, that in what we commonly regard as inflammation the processes he thus separates are inextricably combined, and depend one on the other; the irritant sets up regressive and progressive processes

[1] Glasgow Med. Jour., lxxii., 1909, 321.

at one and the same time, and, with them, increased functional activity of the leukocytes; to banish the term inflammation could only tend to make us forgetful of this essential association. Certainly we must analyze and seek to determine which is in the ascendant in any particular case, and that as an aid to our therapeutics. What is of greater importance is that as a part of our medical and surgical thought we shall always need some one word to embrace the succession of changes taking place in a part as the result of injury to that part; we shall always need in our pathology and surgical pathology chapters bringing together the fundamental data bearing upon this all-important matter. We must retain this word, even though we continue to differ regarding the limits of its application. And this Professor Muir unwillingly admits in the concluding paragraph, "The word inflammation and its representative termination *itis* are far too important constituents of our nomenclature to follow any such course at present." As he says in his concluding remarks, "Inflammation is a convenient but somewhat vague descriptive term."

In a thoughtful lecture, delivered before the Harvey Society,[1] Opie, basing himself largely upon his studies of the enzymes of the wandering cells, to which I shall shortly refer, concludes that inflammation may be defined as the process by means of which cells and serum accumulate about an injurious substance and tend to remove or destroy it. As Ainley Walker pointed out, with reference to an attempted definition of my own, a definition should state what a thing is, not what it tends to bring about. Thus the last clause reduces Professor Opie's statement from a definition into a description.

There is, says he, a fundamental distinction between a reaction which repairs an injury and reaction which renders harmless an irritant substance. "Certain invertebrates with simple structures (hydra, planaria) repair an injury by rapid regeneration of a part removed; phenomena suggesting an inflammatory reaction are wholly lacking." Quite so, if the regeneration be not taken as one of the reactive factors. But in those very same lower invertebrates, if an inert insoluble substance, such as a spicule of glass, be introduced into the tissues, the regenerative process passes imperceptibly into a proliferative process whereby the foreign body becomes fenced off from the rest of the organism. Here, therefore, regeneration and rendering the irritant harmless is one and the same process. And when, in higher vertebrates, a definite irritant, such as the tubercle bacillus, will, according to its virulence, either set up an acute destructive process, or, on the other hand, lead to endothelial and other tissue cell proliferation, it becomes a matter impossible of solution where, according to Professor Opie's definition, attractive as it is, inflammation ends and regeneration and repair begin. Professor Opie as much as confesses this in his admission of uncertainty regarding the origin of the large mononucleate cells of the later stages of the inflammatory process—Metchnikoff's *macrophages* and the "epithelioid" cell of the tubercle. They are actively phagocytic for the

[1] See also Archiv. of Int. Med., v., 1910, 541.

polynuclears and for certain orders of bacteria, *e. g.*, the tubercle bacilli. These clearly "tend to remove and destroy" the irritant, although there is evidence that some of these originate from migrated lymphocytes. He cannot overlook the evidence that some at least of these are the result of proliferation of certain tissue cells of the injured area, which combine thus both destructive and regenerative functions. In short, it has to be admitted that no clear line can be drawn between the irritant-destroying and the reparative processes, and this being so, remembering that, after all, the utility of the concept "inflammation" is to aid us in forming a mental picture of the sum total of the local processes which follow injury to a part, I still consider that the definition given in my former chapter is the most satisfactory, namely, that inflammation is *the series of local changes which constitute the reaction to actual or referred injury to a part.* Let us admit that this definition is so broad that, logically speaking, it must include these later tissue regenerations and overgrowths of tissue cells which we are usually accustomed to exclude from our mental picture of inflammation proper, and include under productive processes and regenerative. We would reply, that it is better to do this than to cut out of our definition processes which are an essential part of the ordinary reaction to injury; no harm is done by including these remoter results of irritation; it is harmful, on the other hand, deliberately to place in another category processes which are part and parcel of the common sequence of events following upon tissue injury.

CAUSATION.

***X*-Ray Burns.**—Concerning the causes of the inflammatory process, considerable attention has been paid during the last few years to *x*-ray burns and their effects. A sufficiency of cases has been collected to permit the adequate study of the burns of varying degrees of intensity. What is perhaps the fullest, as it is the most satisfactory, study has been made by Wolbach.[1]

This may be laid down, that the *x*-rays have little perceptible action upon the epidermis proper—they affect most the underlying dermis, there setting up profound disturbances, telling more particularly and primarily upon the superficial vessels, both hemal and lymphatic. Not only do they become dilated, giving off increased exudate, but their endothelial lining is gravely affected, often becoming loosened, with resultant hemorrhage and thrombosis. Necrotic areas may appear, and, later, connective-tissue overgrowth, as a consequence of which the nutrition of the overlying epiderm is largely reduced. It is this, and not the direct action of the *x*-rays, that leads to the necrosis and ulceration of the epithelium, and that explains the intractable nature of the ulcers —this layer of inflammatory fibrosis intervening between the epidermal layers and their supply of nutrition. Wolbach discusses interestingly how a lesser grade of this same disturbance leads not to necrosis, but to abnormal growth of the epithelium cells and the production of epithelioma.

[1] Jour. of Med. Research, xxi., 1909, 415.

MECHANISM OF CHEMOTAXIS.

To the ordinary mind (here, I imagine, that others are like myself) the phenomenon of the whole inflammatory process most difficult to grasp is the apparently purposeful wandering of the leukocytes out of the veins toward the focus of irritation. It looks, at first sight, as though these simple cells were endowed with intelligence, and yet that is an impossibility; but, if they are unintelligent, what other explanation can be afforded? The increased study of the physics of living matter that has characterized the last decade appears to afford us an explanation. In the first place, this property of moving toward or away from other substances is not a specific attribute of living protoplasm; it can be demonstrated as existing between substances that are not living; thus, as Bernstein[1] has shown, if a dilute nitric acid solution be taken in a flat dish, and a drop of mercury placed in the middle, a crystal of potassium bichromate let fall in its neighborhood leads to a very striking chain of events. So soon, as with solution of the salt, the yellow area of diffusion touches the quicksilver, that exhibits active movement toward the crystal, moves toward it, and flows around it as though to ingest it, in a way that absurdly resembles the movement of an ameba toward and around the mass of food-stuff; indeed, if the crystals be gently moved away, the mercury follows. Similar ameboid movements may be reproduced (Rhumbler)[2] by letting a drop of clove oil fall into a freshly made mixture of glycerin and alcohol. These two do not easily mix, and thus there are regions or currents in the mixture where the alcohol or the glycerin is the more concentrated. Clove oil mixes with alcohol, but not with glycerin. If now, close to the oil globule, a little strong alcohol be dropped, the globule moves actively toward it with pseudopodial motion. Or place a drop of chloroform in water, and touch it with a fine thread of shellac, and the edge of the chloroform droplet extends along it just as the cytoplasm of a leukocyte flows along a chain of anthrax bacilli. Coincidentally, the shellac softens and becomes coiled up within the drop until a fine thread, in length six times the diameter of the drop, may become included within it.

The above phenomena have one common explanation—namely, alteration in *surface tension*. Acting between the particles of any fluid is a cohesion force which attracts the particles one to the other. This force acts equally in all directions—each different fluid has its particular cohesion force—and when a fluid of one order is allowed to fall into a fluid of another, toward the center of the drop the force acts equally, whereas those particles which find themselves in contact with the other fluid are acted on unequally: the forces acting upon them from the neighboring particles of their own order within may be widely different from those exerted by the foreign particles of the suspending fluid without. It is this difference in force that constitutes the surface tension; it is this that causes a drop of fluid, falling through the air, on gaining entrance into a fluid of different density to assume the globular state.

[1] Pflüger's Archiv., lxxx., 1900, 6–8.
[2] Arch f. Entwickelungsmech., vii., 1898, 103.

If, however, the cohesion force of the fluid of suspension be modified locally, so that it approximates more nearly to that of the suspended drop, then on the side on which this happens the surface tension will be reduced. The result will resemble those that follow the distention of a rubber ball which is weak at one point, or otherwise the drop gives way and projects toward the side of weakening. The opposite occurs when the cohesion force of the suspending fluid is locally altered in the reverse direction; then the drop appears to move away from the region of disturbance. Pseudopodial activity on the part of the leukocyte appears to be of the same order, to be at bottom dependent upon variations of surface tension.

So fully is this coming to be recognized that perhaps at the present day biologists are carrying the idea of surface tension to an extreme, and explaining most vital phenomena as originating through variations of surface tension. To such variations lipoid substances are most susceptible, and coincidently the lipoid or fatty bodies present in the cell are coming to be granted an importance almost equal to that of the proteins. These, for example, are profoundly affected by changes in the reaction of the medium, but it is more particularly their power of action as solvents for various substances present in the surrounding medium that modifies their surface tension. Albrecht and others have gone so far as to predicate that the surface layer of cells is largely composed of lipoid substances. Brailsford Robertson, on the other hand, points out that the properties of proteins are ample to account for surface tension phenomena, and dwells especially upon their amphoteric character, their capacity to combine with both acids and bases, the differences in the electric charges held by them in acid or alkaline media respectively, and the differences in surface tension caused by the accumulation of positive or negative ions at one or other locality of the cell surface. Whether we deal in the main with proteins or lipoids, or, as is more probable, with the interaction and combination of both, it is the remarkably unstable equilibrium of the constituent molecules of the cell that is at the basis of alterations of surface tension, motility, and chemotaxis.

THE LOCAL EFFECTS OF THE INFLAMMATORY EXUDATE.

When dealing with the subject of treatment I shall have occasion to refer at some length to Schäffer's important studies upon warmth as favoring arterial dilatation in an inflamed area and accompanying increased exudation. Here note may be made of Klemensiewicz's[1] studies upon such increased exudation in its relationship to capillary stasis. Selecting tissues which could be examined under the microscope, he devised a relatively simple instrument whereby he could measure accurately the degree of pressure necessary to induce capillary stasis. He found that, under the action of local irritants and the consequent increased exudation into the tissues under examination, a distinctly lessened pressure or tension under which this exudate exists

[1] Entzündung, Jena, 1908.

in the tissue spaces is in itself a factor in acting upon the capillaries, preventing excessive dilatation, tending, in fact, to make the exudation self-limited. But if the exudate tends thus to compress the capillaries, still more must its effects tell upon the yet more delicate lymph-vessels. Regarding these we have to accept the modern anatomic teaching of Florence Sabin, MacCallum, and others, that they originate from the veins as a closed set of vessels, and do not open into the lymph-spaces of the tissues. Here, however, is the difficulty—the amount of lymph discharged into the afferent lymph-vessels of an inflamed part is markedly increased. So, also, in cases in which by the action of heat there is increased dilatation of the arteries and increased exudation, this is accompanied by a corresponding distention of the lymph-vessels of the inflamed area. They are dilated, not compressed and emptied. The only explanation that we can suggest for these paradoxic facts is that under the stimulus of the irritant the cell lining the lymph-vessels *actively excretes* the lymph under pressure. Mere filtration cannot explain this distention of the lymph-vessels.

These observations of Klemensiewicz obtain only for superficial tissues; they help, however, to explain why the inflammative dilatation of superficial capillaries of serous surfaces, as again of the lung alveoli, is so much greater than that seen in deeper tissues, and why the amount of exudation from these is so much greater.

ON THE ENTRANCE OF BACTERIA INTO THE HEALTHY TISSUES AND CRYPTOGENIC INFLAMMATION.

The controversy still continues as to the extent to which bacteria gain entrance into the healthy tissues through the intact mucosa, whether of the digestive or the respiratory tract. We do not think that we mistake the general consensus of the majority of recent workers if we state the following:

I. Even in adult animals in perfect health careful bacteriologic study reveals the existence of bacteria in the peribronchial and mesenteric lymph-nodes.

II. In young animals bacteria pass through the intestinal wall with relative ease, being carried inward by leukocytes which have passed out on to the surface.

III. In adult animals in sound health this passage is minimal: lowered vitality, congestion, and slight grades of inflammation or irritation of the intestinal mucosa is accompanied by a marked increase in the bacterial contents of the mesenteric lymph-nodes, with passage of the same into the blood, and so to the other organs of the body.

IV. Isolated bacteria gaining entrance into the lymph-nodes and the blood are rapidly destroyed, so rapidly that the tissues of the healthy animal are potentially sterile.

V. In the adult animal in sound health the carriage inward of bacteria is so slight as to be negligible. With lowered vitality, congestion, or irritation of the digestive or respiratory mucosa it may happen that pathogenic bacteria conveyed inward may reach the blood-stream, and

be arrested in some region of lowered resistance before the fluids and cells of the body have brought about their death. Such bacteria may set up cryptogenic inflammation.

THE PART PLAYED BY THE LYMPH-NODES IN THE INFLAMMATORY PROCESS.

It has for many years been recognized that the swelling and inflammation of the lymph-nodes nearest to the site of primary inflammation is of the nature of a protective reaction, the nodes acting as a filter and preventing or tending to prevent the general diffusion of the irritant. Certain valuable observations upon the efficiency and mechanism of these organs deserve mention.

It is, in the first place, a general impression that the flow of lymph is distinctly sluggish, but evidently our views have been exaggerated in this respect. Inoculation of bacteria or colored particles into the peritoneal cavity are found to result in their appearance in the substernal lymph-nodes within a very few minutes. Buxton and Torrey[1] gained abundant cultures of the typhoid bacilli upon plates made from these nodes ten minutes after peritoneal injection.

Microscopic study showed that the bacilli were in part free, in part within polynuclear leukocytes. Not only this, but even within five to ten minutes such introduced bacilli are to be isolated in fair numbers from the blood. Similarly, Noetzel[2] reports that Bacillus pyocyaneus, introduced into the knee-joint of the rabbit, is to be found in from five to ten minutes later, not only in the inguinal and crural lymph-nodes, but also in the circulating blood. How have they gained entrance? Not, it would seem, through direct entrance into the blood capillaries, but by the agency of the lymphatics.

Thus, Wells and Johnstone[3] have demonstrated very clearly that if, before making the peritoneal inoculation of bacteria, the thoracic duct be ligated, then soon after the injection abundant bacteria are present in that duct *below* the site of ligature, but the bacteria are absent from the blood-stream.

The interesting point in this and allied observations is that, despite our modern conviction that the lymph-vessels constitute a closed system, and that there is not free communication between the peritoneal cavity and the lymphatics of the diaphragm, these bacteria appear in the lymph-vessels with such remarkable activity. We suppose that they are carried in by the polynuclear leukocytes, even if later they become free through the dissolution of their hosts. In the next place, this very rapidity with which bacteria appear in the thoracic duct after intraperitoneal inoculation is an indication that the normal resting lymph-nodes of the mesentery duct do not act as efficient filters. After the first half-hour or so the number of bacteria in the blood rapidly diminishes, and this in spite of the fact that the peritoneal cavity may

[1] Jour. of Med. Research, xiv., 1906, 213; xvi., 1907, 17 and 251.
[2] Beitr. klin. Chir., li., 1906, 740.
[3] Jour. of Infect. Dis., iv., 1907, 582.

still be teeming with bacteria. Examination of the lymph-nodes at this period shows why this is so. The afferent lymph-vessels and sinuses of the nodes are packed with leukocytes. We are inclined to the opinion that the arrest of the bacteria is in this case largely mechanical; that they are filtered out by the close packing of the cells in the sinuses. Opie compares the arrest with Issaeff's resistance period, and quotes Pawlowsky,[1] to the effect that if acute inflammation of a joint be preceded by the injection of a sterile irritant, such as turpentine, some twenty-four hours in advance, the appearance of bacteria in the blood is wholly or almost wholly prevented. Issaeff and Durham's observations show, however, that in the abdominal cavity this resistance period and arrest of bacterial extension are due not so much to mere mechanical hindrance as to leukocytic accumulation, and the indifferent or non-specific destruction of bacteria by the leukocytes which accumulate as the result of an inflammation set up by sterile mechanical or chemical irritants. It is a phenomenon, as I have pointed out elsewhere,[2] of non-specific immunity.

THE FERMENTATIVE ACTIVITIES OF PUS.

Why do we encounter now a purulent, now a fibrinous or serofibrinous inflammation? The mere relative proportions of leukocytes and serum, although evidently a factor in bringing about the contrasted forms, do not seem adequate to explain, nevertheless, why when the polynuclear leukocytes are present in great abundance we find that fibrin formation is characteristically reduced, if, indeed, we do not obtain evidence that fibrin previously present has become dissolved, and this, although paradoxically the presence of leukocytes and their breaking down is generally accepted as an all-important factor in fibrin formation.

Long years ago, in 1891, Leber showed that sterile pus, produced by aseptic irritants, is capable of digesting fibrin and other proteins. In 1899, Achalme separated ferments from pus from various sources, and in 1901 Ascoli and Mareschi demonstrated that aseptic pus, produced by injecting aleuronat into the pleural cavity, undergoes autolysis or self-digestion if removed and kept under aseptic conditions. But it is to Opie[3] that we owe the fullest study of those proteolytic properties of pus, and a fuller understanding of the *rationale* of the different forms of inflammation.

Briefly, in aseptic pus composed of polynuclear leukocytes there can be demonstrated a proteolytic ferment, most active in a weakly *alkaline* medium, still acting when the medium is neutral, but arrested in its action by acid. With one exception the proteolytic enzyme present in the tissue cells, the enzyme concerned largely in autolysis, is more allied to pepsin, and acts in the presence of very weak acid. The one exception, as Opie has shown, is the bone-marrow, and it is the bone-

[1] Zeit. f. Hyg., lxii., 1909, 433.
[2] Principles of Pathology, 2d ed., vol. i., p. 499.
[3] Jour. of Exp. Med., vii., 1905, 316 and 759; viii., 1906, 410. Opie and Barker, Jour. of Exp. Med., ix., 1907, 20. See also Bradley (with later literature), Jour. of Hygiene, x., 1910, 209.

marrow that is the main seat of development of the polynuclear leukocytes. Thus, for example, the lymph-nodes yield an enzyme active in the presence of *acid*, and correspondingly exudates composed of lymphocytes, such as we obtain in cases of subacute and chronic tuberculosis, are deficient in ferment of the first order, but yield a ferment of the second.[1]

Opie terms these *leukoprotease* and *lymphoprotease* respectively. The former is not trypsin, being able to act directly without the intervention of an enterokinase or activator; further, it is much less active than trypsin. It can be demonstrated that this same leukoprotease is present in fibrinous exudate containing polynuclear leukocytes in its meshes. Induce an aseptic fibrinous exudation (by means of aleuronat), collect the fibrin and place it in an alkaline medium, and it undergoes solution.

Why, then, does the ordinary serous or serofibrinous inflammatory exudate, although it may contain abundant polynuclear leukocytes, fail to undergo autolysis? Opie gives the answer. Separate off the cells from the serum, and they are found to be capable of undergoing autolysis and of digesting foreign protein. Add to those cells the serum, and the digestive process is wholly arrested. The serum, therefore, contains some substance which hinders the action of the enzyme—a substance which may be termed *anti-enzyme*. This is associated with the albumin of the serum, for, if the albumin be separated from the globulin, only the former is found active, the latter not. This anti-enzyme is destroyed by a heat of 75° C., and its action is inhibited by acidity of the medium. While evidence is wanting that this is a true antibody, namely, that enzyme and anti-enzyme combine in definite quantities, and while it is not a specific body, the anti-enzyme from the serum of one species of animal having equal powers in arresting the leukoprotease obtained from another species, this much can be said, that, taking a fixed quantity of serum, extracted leukoprotease can be added to it in increasing quantities until a definite point is reached, beyond which the serum is unable to inhibit the proteolytic action of the leukoprotease. It is an action similar to that of the *antitrypsin* of blood-serum which arrests the fermentative acidity of trypsin.

Here, therefore, *the relative abundance of polynuclears and of serum in any given exudate determines the properties of that exudate.* If the serum be in excess, proteolysis cannot be manifested; if the amount of serum be small in comparison to the number of migrated leukocytes, then the anti-enzyme present is inadequate to restrain the action of the proteolytic enzyme, and any fibrin that has been formed becomes digested. So also, where the polynuclears densely infiltrate an inflamed tissue, there the damaged tissue cells are apt to be digested and removed. In this way typical pus makes its appearance, with abundant

[1] The existence of this lymphoprotease has been doubted by Müller, Jochmann, and others; it appears not to be very active. Nevertheless, lymph-nodes in the later stages of inflammation, when filled with large mononuclears, exhibit active proteolysis in the presence of acid, but fail to digest proteins in an alkaline or neutral medium.

polynuclear cells floating in a viscid serum, rich in soluble proteins, devoid of fibrin and of tissue cells.

In this way also we gain an explanation of the widely different effects produced by one and the same pathogenic microbe in different parts of the body. We can explain, for example, why the typhoid bacillus, if it multiplies in the subcutaneous tissues, sets up abscess formation; the very nature of the tissue prevents abundant serous exudation, and so pus formation is favored, whereas in the peritoneal cavity the same bacillus induces an abundant serous exudate.

This, it is true, is not everything; the different pathogenic organisms exert varying chemiotactic properties; the Staphylococcus aureus, gaining entrance into the pleural cavity, is apt to set up a purulent inflammation, the tubercle bacillus a more serous. So, too, with regard to any particular microbe, the nature of the inflammatory manifestation varies with the virulence of the particular strain; *per contra*, the reaction on the part of the tissues varies with the individual, and, what is more, the normal transudates vary in their composition. Thus, Dochez[1] calls attention to the fact that the cerebrospinal fluid is normally devoid of both anti-enzyme and enzyme; any acute accumulation of polynuclears is here accompanied by a relatively unrestrained enzyme action and liberation of presumably irritative products of protein dissociation. Undoubtedly, this enzyme action is a factor that has to be considered. Thus, in acute lobar pneumonia in the earlier stages there is abundant hemorrhagic exudate which undergoes coagulation within the alveoli, whereby hepatization is induced with abundant deposit of fibrin until the alveoli are so distended that further fluid exudation becomes impossible if not self-limiting. But determination of polynuclears into the alveoli is not prevented. These, indeed, are attracted into the alveolar contents in greater and greater numbers, until, by their abundance, they overcome the anti-enzymotic influences of the medium. and digestion of the fibrin shows itself with beginning resolution. It is interesting that in this case we do not obtain true pus formation; the leukocytes, instead of remaining, undergo autolysis—digest themselves. But in other regions, as, for example, the joints, the pneumococci set up a pronounced suppurative inflammation.

That is, we still are far from comprehending all the factors at work in any given case. We do not, for example, know how far the acid or alkaline reaction of the exudate is modified, how far, for example, passive hyperemia, after Bier's method, arrests the suppurative process by rendering the fluid of the exudate more acid, and so inhibiting the activity of the leukoprotease, how far it acts by increasing the exudate and bringing more anti-enzyme to the part. Nor, again, do these observations throw any light upon a parallel function of the polynuclears, that, namely, of liberating bactericidal or bacteriolytic substances. We shall shortly bring evidence to show that sudden increase in the fluid of the exudate favors a dissolution of the leukocytes, and, judging from the favorable results, a marked increase in the bactericidal proper-

[1] Jour. of Exp. Med., xi., 1909, 718.

ties. But, granting all this, these observations of Opie constitute perhaps the most signal advance in our knowledge of inflammatory phenomena accomplished since 1906, when my former chapter appeared.

We have referred above to the favorable results which have been found in several cases to attend passive hyperemia. It is in chronic tuberculous lesions that these results have frequently been recorded. In this relationship it is not a little interesting to note that in lesions of this order we have accumulations not of polynuclears, but of lymphocytes, whose enzyme action acts in an acid medium. It is at least deserving of suggestion that in these cases the passive congestion, by causing increase in the carbon dioxid of the tissues and tissue fluids, encourages activity of the lymphoprotease, and so the resolution of the tuberculous granulomas.

ON LIPOLYTIC FERMENTS.

It is now a generally accepted belief that the tubercle bacillus owes certain of its most distinctive properties, its acid-fast character, and its resistance to various reagents to its possession of a large amount of a waxy substance. Levene and others have, indeed, obtained this wax in workable amounts by making gigantic cultures of the bacilli. As bearing upon the observed fact that polynuclears do not act as phagocytes for tubercle bacilli and appear incapable of destroying them, whereas lymphocytes and large mononuclear cells constitute the main constituents of the tubercle (and giant cells, derived from the latter, can be seen to contain the bacilli in various stages of digestion), it is not a little significant that Bergel[1] and Fiessinger and Marie[2] have demonstrated that both tuberculous exudates and lymphocytic endothelial tissues, such as the lymph-nodes and spleen pulp, contain a lipolytic enzyme. Place a drop of pus from a cold abscess, or of an exudate containing lymphocytes upon a plate of wax, and the underlying wax will become softened and dissolve, a small pit resulting. Ordinary pus, with its polynuclear leukocytes, has no such action, nor has bone-marrow this property.

TREATMENT OF INFLAMMATION.

A study of the first importance upon the effects of different forms of treatment has recently been published by Prof. Schäffer of Breslau.[3]

This is practically the first thorough comparative study upon the subject, and it has resulted in modifying very materially the commonly accepted views. Like much work of the first order, the method employed is so simple the wonder is that it has not been employed years previously. The only hesitation that we may have regarding the results is whether we may surely apply the data obtained from the rabbit

[1] Münch. Med. Woch., lvi., 1909, 64.
[2] Arch. d. Malad. du Cœur., ii., 1909, 545.
[3] Der Einfluss unserer therapeutischen Maassnahmen auf die Entzündung; Mit 11 zum Teil färbigen Tafeln, Verlag von Ferdinand Enke, Stuttgart, 1907.

to man. Doubtless, occasional opportunities will afford themselves for making the necessary comparative observations.

Briefly, Schäffer takes a rabbit, and on one side introduces subcutaneously a catgut or silk thread as a seton, covering the wounds of entry and exit with collodion. If he wishes to study merely a foreign body inflammation the thread is introduced in a sterile condition. If he wishes, on the other hand, to set up one or other order of inflammation, the thread has been previously saturated with some irritant, such as silver nitrate, carbolic acid, or suspensions of staphylococcus or streptococcus cultures, etc. Having introduced this subcutaneously on the one side, the process is repeated symmetrically in the like region on the other, care being taken that the thread lies at the same depth on either side, since the reaction differs materially in muscular tissue and in the looser connective tissue of the subdermal layers and between muscles. Either immediately or when the reactive process is well advanced the lesion on the one side is treated by the application of heat in one or other form, or cold, the lesion on the other side being left untreated as a control. At any given moment the animal may be killed, the areas involved cut out, and the material prepared for microscopic examination. As a routine method sections are made at right angles to the long diameter of the thread.

To put it briefly, whatever method of local application of heat be employed—dry heat, hot air, the thermophore, or the ordinary poultice—the results are of the same order, provided the heat be not excessive. Naturally, the appearances vary somewhat, according as to whether the heat be applied from the very beginning of the inflammatory reaction or after that reaction has become well developed. The phenomena, however, are of the same order in the two cases. As an example of the first we may describe an experiment in which a catgut thread impregnated with a 5 per cent. silver nitrate solution was introduced subcutaneously on either side and the animal killed at the end of eight hours. Here, on the control side, the catgut was found surrounded by a rich collection or infiltration of leukocytes, somewhat sharply defined, the infiltration being more abundant laterally, and less, as can be well understood, toward the epithelial and the muscular aspects respectively.[1] In the neighborhood of the thread was a considerable deposit of silver. On the side that had been treated by moderate heat during the same period the picture was wholly different. At first sight, there appeared to be absolutely no reaction around the thread, but, on careful examination, an extraordinarily powerful hyperemia was seen to be present. The arteries of the neighborhood were dilated to three and four times the size of those on the control side, and were, in fact, as large as the accompanying veins. Lymph-vessels and lymph-spaces in the region around the thread were widely distended, and, in short, there was a serous infiltration of the tissues, which was most extreme in the immediate neighborhood of the thread. The deposit of precipitated silver granules appeared much slighter, the

[1] Schäffer, Berliner Klin. Woch., 1910, p. 817.

result of dilution and dispersion. There was no sign of beginning suppuration. The early application of heat would seem absolutely to have arrested the suppurative process. Now, with higher power of the microscope, it was to be made out that leukocytes are present in the surrounding vessels and in their immediate neighborhood, although they are wanting around the introduced thread, and careful examination with the oil immersion shows not an absence of leukocytes, but the presence of "Schatten." There is not, as in necrotic processes, a degeneration and destruction, first, of the cytoplasm of these cells, the nuclear chromatin remaining stained, but various stages can be seen showing a progressive loss of staining power on the part of the nuclei, which may become absolutely colorless, giving rise to these shadows. There is here, therefore, a process of solution of the leukocytes in the abundant lymph that is poured out around the irritant.

The effects of the favorable local application of heat where there is already active inflammation is shown by repeating the previous experiment, and, at the end of six hours, removing the threads or setons from either side, and then applying heat on the one side for six hours. Here, on the control side, there is a sharply defined infiltration in the region where the thread has run, the lesion being further marked by the deposit of silver. On the heated side, although the cell infiltration has not wholly disappeared, it is obvious that there has been a great diminution in the infiltrated cells, which have also become more diffuse, and the site of the thread is occupied by abundant lymph.

Schäffer points out that if there be already a definite abscess formation, this increased hyperemia under the influence of heat, with an increased accumulation of fluid in the part, must lead to increased pressure, and, doubtless, to the pointing of the abscess along the line of least resistance. His observations, in fact, afford the rationale of employing hot poultices to encourage the "pointing" of abscesses. He has noted further that, as a matter of practice, after such treatment, when the abscess is incised, the pus is thinner, more watery, discharges more freely and completely, and, what is more, a smaller incision is necessary over the pointing abscess. Similar results of the same order were obtained where, in place of chemical irritant, the threads employed had been impregnated with pyococci. There is the same apparent and also actual reduction in the leukocytosis, the same arterial hyperemia and serous transudation of the whole surrounding tissue, with most marked accumulation of fluid immediately around the thread, and, what is remarkable, comparing the control with the treated sides, sections from the latter exhibit fewer bacteria, those present staining, many of them, distinctly more feebly than those on the control side, while further, despite the flushing of the part, it is noticeable that the bacteria are not widely distributed. There is not that evidence that might have been expected of diffusion of bacteria in consequence of the flushing-out process. Schäffer places the upper limit of beneficial application of heat as not above 41° C. (106° F.) by moist heat, and not above 45° C. (113° F.) by dry heat. Above these temperatures he

finds that capillary hemorrhages occur with marked stasis and leukocytic infiltration, so that in some of the experiments the picture came to resemble much that seen in the controls. He would confirm the observations of Filehne, Rovighi, and others that, under the influence of warmth, local infections take on a more rapid and favorable course; in other words, that hyperemia, serous transudation, and solution of the leukocytes are more effective in arresting bacterial growth than is the simple leukocytic infiltration seen upon the control side. We will revert later to the meaning of these observations.

As regards the influence of cold, Schäffer, from his observations, concludes merely that cold retards the course of the inflammatory process. Often the leukocytes which had migrated from the vessels were found immediately outside the veins, forming a layer in this position. They had not migrated from this position to surround the thread—appeared, in short, to be paralyzed. And, clearly, ice-bags and other means of applying cold had no effect in removing the inflammatory infiltration, once it became developed. At most, he observed that the effects of these cold applications do not persist, and that temporary applications of cold might be followed by a reactionary hyperemia similar to that induced by heat. This temporary effect of cold applications, he points out, is markedly different from the more prolonged results of hot applications. His observations show that long-continued applications of heat are unnecessary, not to say inadvisable. Following upon a moist heat of 106° F. for an hour or two, the dilation and the inflammatory edema may persist for twenty-four hours. He urges, therefore, repeated short applications of heat as the more appropriate treatment. As regards different forms of bandages, he is led to the conclusion that wet bandages, separated from the surface by a water-tight membrane and left unchanged as long as possible, afford the same picture as that given by hot poultices and by dry heat properly applied, and that they, therefore, form the most satisfactory and simplest means of aiding the inflammatory process and bringing it to a favorable termination.

These observations throw a very strong light upon the rationale of Bier's treatment by induced hyperemia. Evidently the system can attack and destroy infective agencies by one of two means, either through phagocytosis pure and simple, or by a method which liberates the proteolytic ferments and bactericidal agencies from the leukocytes, so that the destruction of the invading organisms becomes humeral and extracellular. Evidently, also, if we are to accept Prof. Schäffer's results, the process of increased exudation of the vessels plus solution of the leukocytes is the more rapid and the more effectual, at least as regards the destruction of the ordinary pyogenic micrococci. What it is in the inflammatory exudate or edema fluid that induces this striking dissolution of the leukocytes has still to be determined: whether we deal with a physical action, alteration of tonicity of the fluid that bathes them, or with the actual presence of some body in the exudate that reduces the surface tension of the cells, and so favors

the passage outward of their contents. But evidently it is an important and hitherto little recognized process in successful arrest of bacterial activities.

Cell Proliferants.—The latest observations upon the treatment of skin wounds would seem deserving of note as affording an indication that chemotaxis is a property influencing not merely the wandering cells of the body, but the fixed tissues also, and that cell proliferation and progressive tissue changes are induced by the products of cell activity and dissociation liberated in or applied to the inflamed area.

First to be noted is Bernard Fischer's observation[1] that a drop of scharlach R., dissolved in olive oil, introduced by a fine needle from one side of the rabbit's ear, through the cartilage into the subcutaneous tissue of the other side, leads to a remarkable down growth of the Malpighian layer of the epidermis of that other side, so that finger-like processes of the epiderm extend into the area occupied by the oil drop. This attraction with the accompanying cell proliferation can only be explained as primarily of chemotactic nature.

Next in order, attention may be called to the observation recorded by more than one surgeon that the rate at which an open wound " skins over " from the periphery is accelerated in a remarkable manner when one or more skin-grafts are planted over the free surface. It has been found that it is not the mere growth activity of these grafts that is responsible for this phenomenon, because the same has been noted where epidermal tissues from other species have been implanted—*i. e.*, grafts which do not " take," whose cells inevitably degenerate and die. The only solution that occurs to us capable of explaining this accelerated growth is along the same lines of chemotaxis, namely, that the products of the cell activity and cell degeneration of the graft diffusing over the surface of the wound act like the oil in Fischer's experiment, and induce an accelerated and associated translation and proliferation of the epithelial cells at the periphery. Some years ago Leo Loeb demonstrated the active movement of the epidermal cells at the periphery of a healing wound, showing that even in the absence of cell multiplication what had been a many layered epiderm becomes represented at the edge of the wound by a layer but one or two cells in thickness—a change that can only be produced by the cells moving one over the other.

Attention may in the next place be called to the experiments of H. C. Ross on the induced multiplication of leukocytes outside the body on the surface of gelatin media.[2] Ross found that extract of hemal glands and of many dead and decomposing tissues, when mixed with the jelly, stimulate active division of the mononuclear leukocytes. Studying more fully the substances capable of acting in the cells in this way, Ross and Cropper found that they dealt particularly with bodies having the amidin grouping, notably protein dissociation products such as

[1] Verhandl. deutsch. Pathol. Gesellsch., x., 1907, 20; Münchener med. Woch., liii., 1906, 204.

[2] Induced Cell Reproduction and Cancer, London, John Murray, 1910. See also Sir R. Ross, Proc. Royal Soc. of Med., v., 1911, No. 2, Pathol. Sect., p. 103.

creatin, xanthin, guanidin, acetamidin, methylamin, etc., and certain anilin dyes. They speak of these bodies as *autecics*. Other bodies of an alkaloidal nature (cholin, neurin, etc.) while themselves incapable of causing this cell division, have a stimulating or accelerating action when present. Along with bodies of the first order, Ross notes that certain of these autecics placed upon chronic ulcers induce rapid cell growth.

And lastly, and independently, C. J. Macalister,[1] of Liverpool, studying the action of the symphytum, or common comfrey, has found in its active principle allantoin, which would appear to be a potent cell proliferant. The comfrey is a large weed allied to borage, and from Saxon times it has had a popular repute in England and France in connection with the treatment of wounds and fractures (" clown's wound wort," " bone-set "). Culpeper and the old " Dispensatories " all speak of the virtues of the root, and, while not official, it is referred to in Martindale and Westcott's *Extra Pharmacopœia* and Wood and Bache's *Dispensatory of the United States of America* (1870).[2] Macalister, making a strong infusion of the root, found that it possessed striking properties in bringing about marked epithelial growth over long-standing ulcers. Titherley isolated from the root a crystalline body having the same active powers, and this was shown by subsequent investigations to have the empirical formula and all the properties of allantoin. It is not a little significant that allantoin, $C_4H_6N_4O_3$, is found both in animals and plants; indeed, it is obtainable with ease by the alkaline oxidation of uric acid. We have here, in short, a body which, if not in man an end-product of purin metabolism, is allied to Ross' group of autecics, and we would appear to be at the threshhold of a new phase in the treatment of inflammation, that, namely, of the isolation and employment of cell proliferants of a group of bodies of protein or nucleoprotein origin which hasten the reparative process in wounds.

[1] Brit. Med. Jour., 1912, i., 10.
[2] See Marsden, Brit. Med. Jour., 1912, i., 336.

CHAPTER LXXXVIII.

SUPPURATION, ABSCESS, SINUS AND FISTULA, ULCER, AND GANGRENE.[1]

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TREATMENT OF SUPPURATIVE PROCESSES.

In the treatment of inflammation and suppuration "antiphlogistic" methods were formerly employed, in which starvation and the letting of blood were prominent features. This was done with the idea that inflammatory processes were harmful and foreign to the body, and that their removal could best be accomplished by the reduction of vascular congestion. The point of view, however, has gradually changed, until inflammation is now regarded as one of the bodily functions provided by nature as a means of defense against bacterial invasion. Local or general anemia is no longer desired, because it is recognized that in the blood are to be found the real defensive agents of the tissues, in the shape of phagocytes and alexins, which destroy bacteria and neutralize their poisons. Upon this theory rests the justification for the modern treatment of suppurative conditions by means of heat, passive hyperemia, vaccines, antiferments, vacuum-chambers, etc., all of which, apparently, merely aid the natural functions of the body.

Following the recognition of the pathogenic properties of micro-organisms efforts were for a long time mainly directed toward asepsis and antisepsis; but, without losing sight of these vital factors, attention is now being turned to the importance of local and general bodily resistance, particularly in their relations to the blood, thus recalling the older ideas regarding "good" and "bad" blood, which have almost been forgotten.

Vaccine and Serum Therapy.—When a colony of pyogenic bacteria establishes itself within the tissues, a combat begins between the resistance of the body and the poisons of the germs. This resisting power is mainly located in the serum and in the white corpuscles of the blood, and is brought into action by means of local congestion—inflammation. As a rule, innumerable leukocytes appear upon the field, varying in number according to the chemotactic properties of the bacterial toxins. Among other things, these leukocytes possess two prominent characteristics: the power of devouring micro-organisms (phagocytosis) and the ability to form, in connection with the proliferating tissue-cells, a barrier between the focus of infection and the remainder of

[1] Supplementary to Chapters VI., VII., and VIII., Vol. I., pp. 228–347.

the body. In this bacterial strife many leukocytes perish, forming pus, and in their dissolution liberate *proteolytic ferments*, which cause the liquefaction of the surrounding tissue-cells, thus forming and enlarging the abscess-cavity.

The blood-serum also takes an important part in the defense by furnishing a number of chemical substances called *antibodies*, the most prominent, for present purposes, being *opsonins*, *bacteriolysins*, and *antiferments*. The duty of the opsonins is to so " sensitize " the bacteria as to permit of their more ready destruction by phagocytes; while the bacteriolysins and antiferments respectively kill the germs and oppose the proteolytic action of their ferments—the whole process being thus directed toward the removal of the cause of suppuration and the inhibition of its destructive effects.

It is likely that small quantities of antibodies always exist in the blood, or at least the ability quickly to produce them, their increase being more or less rapidly stimulated by substances called *antigens*, of which bacterial toxins are prominent examples. Therefore, it seems evident that if enough bacterial antigens can escape from an abscess into the circulation, and if the system has power to respond with a sufficient quantity of antibodies, recovery should result. Several things may, however, prevent this, prominent among which are: (1) an impassible barrier between the micro-organisms and the circulation, as in old abscesses with thick walls; and (2) too little reaction on the part of the blood. The latter may arise from overwhelming with toxins in acute sepsis; or from feeble resisting powers, which vary markedly in different individuals and at different times.

Among the means recently suggested to assist nature in her efforts is the production of an *artificial immunity* through the introduction of additional antigens (*active immunity*), or by means of serum filled with preformed antibodies (*passive immunity*). In the former method dead cultures of bacteria are employed, and in the latter the blood-serum of previously immunized animals—diphtheria antitoxin, for instance. The *sera* require more time for their preparation than can usually be given, while the *bacterins* may be quickly made. This is unfortunate, because the former appear, in the main, to give better results than the latter. The vaccines obtained directly from the infected individual are known as *autogenous*, and those from other sources as *heterogenous* or " *stock-vaccines.*" The latter are usually compounded from different strains of the same germ, while *mixed vaccines* are made from separate species of germs.

At present the **treatment of suppurative processes** is usually attempted with bacterins, preferably autogenous, although many ready-made stock-vaccines are furnished in convenient form. At first much enthusiasm was manifested and extravagant hopes aroused, but experience has proved to be somewhat disappointing, in spite of many confident claims to the contrary. The best results are obtained in localized, chronic, and subacute suppurations, in which the absorption of antigens is relatively slight and the blood-supply inadequate,

owing to connective-tissue or other encapsulating barriers. In certain cases the action of the vaccine may perhaps be considerably enhanced by the employment of Bier's method of passive venous hyperemia, as elsewhere described.

Very acute or **generalized infections,** in which the reactionary powers are already more or less overwhelmed with antigenic toxins, are seldom if ever benefited by vaccination, occasional reports of apparent successes being open to criticism because spontaneous recoveries often occur. As a rule, when the temperature is falling and the pulse becoming weaker and more rapid, with other signs of severe poisoning, vaccines are probably useless; but when the temperature is maintained and the general condition remains reasonably good they may be tried, although the effect is often sadly disappointing. Hence it follows that if vaccines are to be of service they should be given early, while the recuperative powers are still active.

Much better effects have been obtained with staphylococcic than with streptococcic vaccines; in fact, it may be said that clinicians have largely lost faith in the use of the latter, particularly in those of the "stock" variety, although Weaver and Tunnicliff have recently shown that four out of five commercial streptococcic vaccines produced immunizing effects in guinea-pigs. Rapid recoveries often occur in staphylococcic infections of the skin, such as small carbuncles, pustules (acne), boils, and especially in furunculosis. In fact, it has even been asserted by Deaver and others that vaccination should be the method of choice in the treatment of such cases. Probably something can also be gained, as regards time at least, in long-continued suppurations, such as frequently follow infections of the extremities, and stubborn sinuses and wounds which are slow to heal are sometimes favorably influenced.

Whether the **prophylactic use of vaccines** prior to operations will ever be generally recognized is yet to be seen, but so far comparatively little has been done in this direction. For this purpose mixed vaccines of staphylococci, streptococci, and colon bacilli may be employed (Ritchie). Tuffier and Rouville assert that it has not been demonstrated that immunization can be accomplished by pre-operative vaccination.

It should never be lost sight of that in suppurative conditions vaccine therapy must at present be considered merely as a more or less valuable adjunct to ordinary and recognized surgical procedures and not as a curative measure in itself. When pus is present it should be evacuated, and when moist heat or drainage are indicated they should promptly be used, just as has always been done.

The **"opsonic index,"** introduced by Wright, is no longer regarded by clinicians as an infallible indication as to size and frequency of dosage, because of its uncertainty and the difficulty of its accurate determination. The clinical symptoms and course of the individual case are considered to be much more reliable. There is some difference of opinion as to whether treatments should be administered at longer or

at shorter intervals, but the preponderance of evidence seems to be in favor of the former, a good working average being about five or six days. The doses should be small rather than large, especially if there is already a tendency to " overvaccination " or if the intervals between injections are short. A moderate dose of streptococci approximates 15,000,000 to 25,000,000, and of staphylococci, 50,000,000 to 200,000,000.

From what has been said it will be seen that the use of vaccine therapy requires not only a careful study of cases, but also considerable technical skill. Hence, in order to obtain the best effect with the least danger, the procedure should, as a rule, be employed only by those who have been properly trained in both of these directions.

In **surgical tuberculosis** there is much diversity of opinion regarding the usefulness of vaccine therapy. In bone and joint lesions the opinion among orthopedists seems to be rather unfavorable (Ridlon, Goldthwait, etc.), but with tuberculous lymph-nodes the results are undoubtedly better, Murphy and others claiming almost invariable success in cases treated before extensive caseation and liquefaction have occurred. Although tuberculous abscesses may be benefited by a prolonged course of tuberculin, other and more reliable methods of treatment should be used in conjunction. If much necrotic tissue is present, in the shape of caseous masses or bone sequestra, surgical procedures are always indicated. When the infection is a mixed one, the use of bacterins may be advantageously alternated with injections of tuberculin, as practised by Willard and Thomas.

Antiferment Treatment of Abscesses.—This was introduced by A. Müller in 1907 and has been more or less extensively employed since then, principally by foreign surgeons. Its theoretic justification seems clear enough, although its practical utility has not been so satisfactorily demonstrated. In every acute abscess the strife between the tissues and the invading bacteria is accompanied by the death of vast numbers of polymorphonuclear leukocytes. In disintegrating they liberate a ferment known as *proteolysin*, which possesses the power of dissolving the surrounding albuminous tissues and thus promoting their absorption. In this manner the abscess enlarges itself through the destruction of its environment. The toxic substances which are taken up by the circulation produce fever, loss of appetite, and the various deleterious effects accompanying purulent inflammation. Hence it seems reasonable to assume that if this proteolytic action could be inhibited much good might often be accomplished by ameliorating general symptoms, by lessening the local destruction of tissue with its resulting deformity, and by cutting short the inflammatory process.

Nature attempts to do this by means of *antiferments* contained in the serum of the blood, which have the power of neutralizing the proteolytic ferments of the leukocytes, although they have no bactericidal action. Unfortunately, however, in many inflammatory conditions the circulation is so impeded that these substances cannot reach the abscess-cavity in sufficient quantity to produce the desired effect. E.

Müller proposes to remedy this deficiency by supplying large amounts of serum artificially, through injections into abscesses, irrigations of suppurating surfaces, and packing of pus-cavities with saturated gauze. Through experimentation he found that sterile serum, obtained from the tunica vaginalis and the peritoneal and pleural cavities, was particularly rich in antiferments, most of his work being done with fluids from hydroceles and cases of ascites. Serum from the patient's own blood may be used if desired, as may also a preparation known as *leukofermentin*, which is manufactured from the blood of the horse and is said to be efficient. Plain horse-serum has also been recommended.

The method employed in closed abscesses is to evacuate the pus and insert the serum through a small incision, a canula, or a large aspirating needle, with due regard to surgical cleanliness and to the avoidance of overdistention of the cavity. A preliminary irrigation with normal salt solution may be of advantage when the pus is thick or the cavity unusually large or irregular. When the case progresses favorably the pus soon becomes watery, the general and local symptoms rapidly subside, and the abscess disappears within a few days, leaving little if any deformity. Success of this character is claimed by a number of investigators in about 50 per cent. of favorable cases without reference to the species of bacteria concerned, but this has not been substantiated by others.

The general opinion, as voiced by Hesse, seems to be that, as a rule, this procedure should not be employed in acute closed abscesses, because of the likelihood of failure, the frequent necessity for repeated injections, the danger in delaying operative procedures, and the possibility of producing anaphylaxis. It is better to use it merely as an adjunct to ordinary surgical measures, in the form of irrigations or of saturated gauze packing, when it may contribute to a more speedy and satisfactory recovery. When the pus-cavities have smooth walls, and especially when encapsulation exists, the chance of success by injection increases, hence the method should be particularly applicable to such a condition as an inflamed bursa. The passive hyperemia of Bier may be combined with the antiferment treatment to advantage.

By determining the presence or absence of proteolytic ferment, a differentiation may be made between ordinary and tuberculous pus (Müller-Jochmann test).

The Ferment (Trypsin) Treatment of Cold Abscesses, Tuberculous Fistulæ, Etc.—This is the exact opposite of the antiferment treatment. In ordinary abscesses antiferments are introduced in order to inhibit excessive action of the leukocytic proteolysins, but in tuberculous abscesses, according to Jochmann, the corpuscular elements are deficient in these enzymes, and they should be added in order to promote solution and absorption of the albuminous contents. In other words, we should try to render "warm abscesses cold and cold abscesses warm." Considerable success is claimed for the method, especially in suppurative processes of the soft parts and joints, and even in sinuses, ulcers, and tuberculosis of the tendon sheaths; in fact, just such cases as are

often treated with iodoform and glycerin, bismuth, etc., which probably also owe their beneficial effects to the same general principle, namely, their chemotactic action upon ferment-bearing leukocytes. The ferments, however, possess the advantage that they may be used in smaller amounts and are free from danger.

At first Jochmann employed ferments made from bone-marrow, spleen, and human pus, but later he determined that as good if not better results followed the use of trypsin, from the pancreas of cattle and hogs, which can now easily be obtained in sterile ampullæ (1 per cent.) ready for injection. The glycerin in these ampullæ being too strong, it should be diluted about ten times with normal salt solution.

When trypsin is injected into normal tissues neither local nor general effects are produced, but they may both occur to a moderate degree where tuberculous lesions are concerned, owing to increased activity in the processes of absorption. In the treatment of abscesses of the joints or elsewhere, 1 to 2 c.c. of the trypsin solution are introduced through a canula or a large aspirating needle inserted obliquely where the skin is not too thin. Only a few applications are necessary in some instances, while in others many may be required. In favorable cases the contents of the abscess rapidly fluidify and become brownish in color, granulation tissue taking their place as absorption progresses.

Sinuses should not only be irrigated and filled, but the trypsin should also be injected, when practicable, into their surrounding walls.

When joints are treated, injections must be made in various places not only within the cavity, but also around it, so as to insure thorough distribution of the material, because it must be in actual contact with the diseased tissues in order to act upon them. The tissue injections cause pain, but it is seldom excessive, and may be modified by the addition of novocain to the trypsin. Dry trypsin powder can sometimes advantageously be used in connection with tuberculous ulcerations.

For a number of years J. B. Murphy has employed, with good results, injections of 2 per cent. formalin and 10 per cent. iodoform in 88 per cent. glycerin in the treatment of tuberculous abscesses. Others have combined the formalin with Beck's bismuth paste, especially in the presence of mixed infections with streptococci. Like other things, the formalin mixture probably owes most of its efficiency to its chemotactic action.

Leukoprophylaxis.—Numerous efforts have been made to obtain immunity to surgical infection by artificially increasing the number of leukocytes, either locally or generally. A general leukocytosis can experimentally be obtained in animals by the administration of various substances, including nucleinic acid and thallianin, but the clinical results in man have not been convincing. The same may be said of the local leukocytosis produced by leaving in the peritoneal cavity, following an operation, a quantity of physiologic salt solution, nucleinic acid, horse-serum, olive oil, etc. In this connection should be mentioned the aseptic abscesses produced by the injection of chemicals (see Vol. I.,

p. 228), and also the various "setons" and "issues," which have long since been abandoned.

Treatment by Means of Hyperemia (Bier).—A vast number of contributions relative to the treatment of acute and chronic suppurative conditions by this method have appeared in recent years. The final judgment may be regarded as favorable, although much of the original enthusiasm seems to have disappeared, and the method has not been adopted by the profession in general as extensively as at first seemed probable. This apathy is perhaps due to several causes: to fear of damage from the constricting rubber band, to lack of knowledge and confidence, and to the uncertainty of the results and the length of time often necessary to obtain them. Especially in non-tuberculous suppuration, the tendency has been more toward the employment of constriction-hyperemia as an adjunct to ordinary surgery rather than as a curative measure in itself; the idea being first to incise the affected part, perhaps making a smaller opening than is ordinarily considered advisable, and then to apply constriction, thus securing a better "external" in contradistinction to "internal" drainage. The procedure is supposed to inhibit sepsis, lessen suffering, increase drainage of the tissues, and hasten recovery, and there is unquestionably considerable truth in this, although the results are not always as brilliant as we should like to have them. On the other hand, Frangenheim expresses the opinion, based on extensive animal experimentation, that passive hyperemia has no effect upon the ordinary bacteria. In no instance could he prevent abscess formation, but, on the contrary, suppuration was hastened and increased, and was often accompanied by excessively stubborn infiltrations of the surrounding tissues.

It should be more generally known that serious infections may often be checked or ameliorated by the early use of passive hyperemia before suppuration has appeared. This is of particular moment in septic conditions of the fingers, where the application of a moderately tight rubber band around the proximal phalanx for a few hours daily may result in the speedy disappearance of the difficulty.

The technic, which is sufficiently described in Vol. I., p. 252, has not been essentially altered. It is simple enough in most cases, although some conditions require the use of quite complicated and expensive apparatus. The small vacuum cups employed for suction in sinuses and abscesses can now easily be obtained, and may be used to much advantage in many instances.

Different theories have been advanced to explain the action of passive hyperemia. Some of these are: the autovaccination from local retention of bacterial products; the antiferments in the accumulated blood; the bacteriolysins; the increased phagocytosis; the supposed augmentation of nutrition; the fixation of an increased amount of oxygen by the hemoglobin, and the mere improvement in drainage from a reversal of the lymphatic flow. It is possible that all of these factors may play a part in the general phenomenon that "nature cures by congestion," which has been taken advantage of for ages in the em-

pirical application of poultices, cups, liniments, irritating plasters, and blisters.

Experience has shown that Bier's method may sometimes be used to advantage in appropriate cases in connection with bismuth-paste, ferments, or vaccines.

Oxygen Treatment.—The application of pure oxygen in various suppurative processes ("Thiriar method") is recommended by Weiss and Sencert, who claim that it not only increases the diapedesis of leukocytes, but also augments their phagocytic properties. If the *x*-ray is used in addition, the oxygen is said to be converted into ozone and the beneficial effects correspondingly increased. It appears to be of especial service in peritonitis, but may also be employed in suppuration of the joints, the pleura, etc., as well as in many phlegmonous conditions and even in gangrene. The procedure consists in exposing the affected part to a continuous stream of oxygen which is conducted into the peritoneal or other suppurating cavity through a drainage-tube, and allowed to escape, if necessary, through other tubes placed at some distance from the first.

DIAGNOSIS AND TREATMENT OF SINUS AND FISTULA.

Until comparatively recently the management of sinuses has been unsatisfactory, it being often difficult to ascertain their origin or to trace them in their ramifications, our efforts being largely confined to guesswork and to the use of colored solutions and probes. Even when accurate diagnosis was possible, treatment, operative or otherwise, frequently failed to effect a cure.

Within the last few years, however, several procedures have been developed which promise better results; the most important being the employment of bismuth paste, vaccines, passive hyperemia, vacuum cups, and the "ferment treatment" by means of trypsin. With all of these methods, however, a necessary preliminary is the removal of foreign bodies that may be present, such as bone sequestra, non-absorbable ligatures, calcareous nodules, etc. These may often be located with the *x*-ray. The best results have been obtained in tuberculous lesions, although other kinds of chronic sinuses may be benefited.

Beck's Bismuth-paste.—In 1906 E. Beck recommended the use of subnitrate of bismuth in the diagnosis and treatment of chronic sinuses and tuberculous cavities. The method has since been widely adopted in this and other countries, with a considerable measure of success. It is simple, painless, and quite free from danger when proper precautions are employed. According to Beck, the method is applicable to "all chronic suppurative sinuses, fistulæ or abscess-cavities, whether of tuberculous or other infectious origin, with the exception of fistulæ of the gall-bladder, pancreas, or those communicating with the cranial cavity." Beck states that 70 per cent. of a long series of cases were cured without surgical intervention, and that only 6 were ultimately given up as hopeless; but it should be understood that the experiences of many other surgeons, although in the main encourag-

ing, have not been universally so favorable as that of the originator of the method.

Technic.—The formula for diagnostic and most other purposes consists of subnitrate of bismuth, 1 part (33 per cent.); yellow or white vaselin, 2 parts (67 per cent.). The vaselin should be sterilized by boiling, and while it is still hot the bismuth may be added. The latter must be pure and *free from arsenic*, so as to avoid disagreeable and even dangerous symptoms.

In order to keep water out of the paste, which would interfere with its usefulness, the receptacles in which it is prepared and conserved

FIG. 1.—TYPES OF SYRINGES USED FOR BISMUTH-PASTE INJECTIONS. (Beck.)
A, Glass syringe for sinuses; B, glass syringe for empyema; C, metal syringe for rectal cases.

and the syringe with which it is injected must be sterilized by dry heat, and if the plunger of the syringe needs lubrication, oil and not water should be used. For the same reason there should be no preliminary irrigation of the part to be treated.

For injecting the paste, an ordinary glass syringe with a rounded end is sufficient in most cases, although instruments of special shape are sometimes required, as in certain forms of rectal fistulæ (see Fig. 1). A sharp needle should *never* be used, because a vein might be penetrated, thus leading to pulmonary emboli. The material, after

fluidification over a water-bath, is drawn into the warmed syringe, the nozzle of which is pressed firmly against the opening of the sinus and the piston slowly depressed until the cavity is filled. This is indicated by the resistance, by a feeling of tension on the part of the patient, or by regurgitation of the paste. The sinus or cavity should not be cureted or otherwise previously prepared, except, perhaps, to clean its orifice with alcohol. It is absolutely essential, both for diagnostic and therapeutic purposes, that *the bismuth should penetrate into all recesses*, and failure to accomplish this may be responsible for lack of success.

Following a satisfactory injection it is marvelous what an accurate knowledge can be obtained of the minute ramifications of a compli-

FIG. 2.—TUBERCULOSIS OF SACRUM, MISTAKEN FOR HIP-JOINT DISEASE. (Beck.)

cated sinus by means of a radiogram, especially if stereoscopic pictures are obtained. One is often surprised at the devious course of suppurating tracts and at their unsuspected origins (Fig. 2).

In cases of long standing, and those which have begun to yield to treatment, it may occasionally be desirable to employ a paste of firmer consistency, which affords a better support to the advancing granulations and has less tendency to work out of the sinus. The formula for this is: bismuth subnitrate, 30 per cent.; paraffin (120° F., melting-point), 5 per cent.; yellow or white vaselin, 60 per cent.; white wax, 5 per cent.

In the **treatment of cold abscesses** their contents are evacuated

by means of a short incision, through which are introduced not over 100 gm. of 10 per cent. bismuth in vaselin, without drainage of the cavity or closure of the wound. Gentle massage may assist in a more thorough distribution of the paste. As contraction of the abscess takes place the small opening is closed against bacterial invasion by the bismuth, which is gradually forced through it, thus avoiding the disastrous effects of mixed infection and "hectic fever." One injection is usually sufficient, although it may become necessary to reopen the incision in order to let out accumulated serum. The copious dressings should frequently be changed, with the utmost regard for surgical cleanliness.

Good results are often obtained in *thoracic empyemata*, even when the cavities are large and of long standing, although many months are sometimes consumed in treatment. In order to avoid danger of poisoning when a very large quantity of paste is employed, the amount in excess of 100 gm. should be removed with olive oil within twenty-four hours, providing it does not work out spontaneously. Closed empyemata may sometimes be cured in this way without the inconvenience associated with drainage, but the attempt should be made with great reservation and caution.

Long and narrow **fecal and urinary fistulæ** may occasionally be obliterated with bismuth-paste, the postoperative ones being more favorable than those due to tuberculosis. The procedure is not effective, however, in large or short fistulæ, and should not be employed until the tract becomes chronic and its walls sufficiently strong to avoid the danger of bursting.

Attention has been strongly attracted to the treatment of **anal and rectal fistulæ** with bismuth, but unless the cases are carefully selected and the proper technic scrupulously followed, disappointment is apt to result. It is essential that the fistula should be chronic, its opening into the bowel not too large, and it must be of such a character that it can be completely filled in all its ramifications. Even then failure is frequently encountered.

With the patient in the knee-chest position, the part is cleaned with alcohol and the paste slowly injected without force until a feeling of distention is experienced, the escape of material into the bowel being controlled, if necessary, by pressing a finger against the internal opening of the fistula. Special syringes with long curved points (Fig. 1) are used for injecting certain fistulæ through a proctoscope from within the bowel.

In the **tuberculosis of glands and joints** Beck advises against the use of bismuth before the formation of an abscess has occurred; in fact, it is probably unwise to attempt the injection of solid tissues under any circumstances.

Therapeutic Effects.—These are probably largely due to chemotactic action, the attracted leukocytes furnishing a proteolytic ferment which stimulates the stagnant activity of the surrounding tissues. In addition to this, chemical action, from the liberation of small quanti-

ties of nitric acid, is possibly of some assistance; and there is no question regarding the importance of the mechanical support afforded the new granulation tissue by the presence of the injected material. It has even been suggested that the radio-activity of bismuth may exercise a curative effect, and, with this idea in view, Beck has sometimes employed the *x*-ray at intervals of a few days with favorable results, the action being apparently increased by the addition of salicylate of strontium to the paste. It is also claimed that the efficiency of the paste is increased by the incorporation of ½ to 1 per cent. of formalin, especially when streptococci are present.

If the purulent discharge rapidly becomes serous, it will often not be necessary to give another injection. In any case, the first treatment should usually not be repeated within a week. The aim, however, should be to keep the cavity filled until it is healed, which may necessitate injections every three or four days. If improvement is going to result, it should be apparent within a month at most. If inflammation or increased suppuration, requiring drainage, should occur, it usually means that some part has not been reached by the injection. When the cure is complete the bismuth is slowly absorbed and replaced by connective tissue.

Dangers.—The method, although in general harmless, is not free from danger, a number of instances of severe poisoning and a few deaths having been reported. Beck himself advises "a healthy conservatism in the use of the paste." There are two distinct varieties of poisoning, according to Beck:

(1) *Acute nitrite poisoning*, from the internal use of bismuth. This is the most common form, and is due to the rapid intestinal formation and absorption of nitrites with a consequent methemoglobinemia, leading to cyanosis, dyspnea, abdominal cramps, and diarrhea.

(2) "The slow but constant absorption of the metallic bismuth from either the intestinal tract or the serous cavities, or when injected into wounds—*bismuth poisoning*. The first symptom, a slight lividity of the skin, appears during the second or third week. Later we find small blue ulcerations of the gums and back of the wisdom teeth, and a black discoloration underneath the tongue. Soon thereafter the patient complains of nausea, headache, and frequently diarrhea. The urine contains epithelial casts and some albumin. If the progress is not checked, the ulcerations will enlarge, the teeth become loose, and the patient becomes cyanotic and begins to lose considerably in weight, and finally may succumb to the effects of poisoning."

From the standpoint of safety, it is better not to exceed 100 gm. at the first injection, although subsequently this amount may be considerably increased, even up to 20 ounces (Beck), especially in cavities with large openings, such as old empyemata. In very susceptible individuals poisoning has even been known to occur following doses of but a few grams. Large quantities must not be inserted within the peritoneal cavity; and recent sinuses following operation, especially about the abdomen, should never be injected, not only for fear of burst-

ing their walls and of poisoning, but also because they may heal spontaneously if let alone.

If alarming toxic symptoms appear, they can almost always be rapidly checked by immediate removal of the bismuth by washing out with warm, sterile olive oil. Beck advises, however, not to regard too seriously the slight oral manifestations, which frequently mean but little, and are really of favorable prognostic importance. When necessary the oil may be left in for from twelve to twenty-four hours, and the resulting emulsion sucked out with an appropriate syringe armed with a rubber catheter. The material should never be scraped out for fear of injuring the protecting granulations and increasing absorption.

In the interests of safety, various substitutes for the subnitrate of bismuth have been recommended, such as the subcarbonate, oxychlorate, and subgallate of bismuth, the oxid of iron, and various emulsions of chalk and other substances. Although these materials may be satisfactorily used for diagnostic purposes, Beck firmly insists upon the superior therapeutic properties of the subnitrate, in spite of reports to the contrary, especially as regards the subcarbonate.

Operative Treatment of Sinus and Fistula.—Anal Fistula (see also Chapter on Rectal Surgery, Vol. VI., p. 625).—Increased stress has been laid upon the preservation of the sphincters in anal fistula, especially the internal, which is by far the more important of the two. This is best accomplished, in suitable cases, by turning back from the margin of the anus a flap large enough to include in its substance the fistulous tract and all its ramifications (Mackenzie), which are then dissected from the under surface of the flap and the rectal opening closed by catgut from within the bowel.

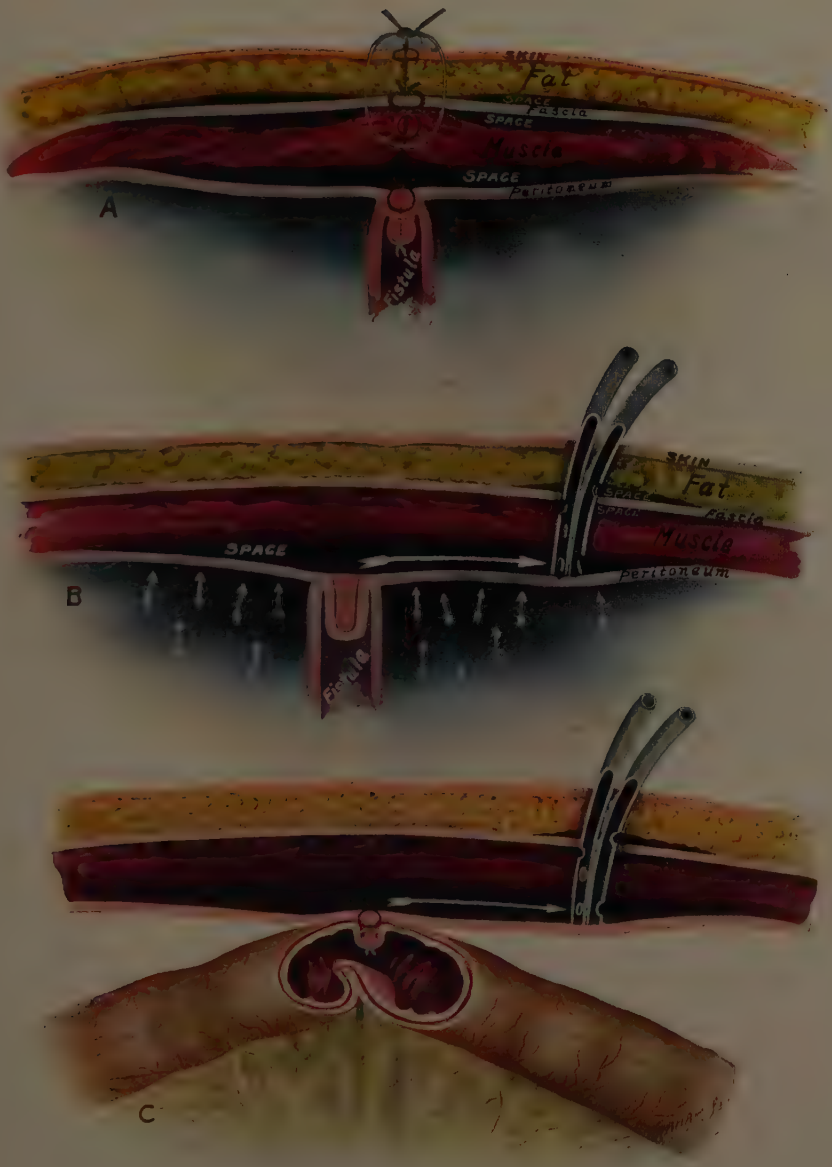
A strong plea has been made by Pennington and others for a return to a modified form of the old ligature treatment of anal fistulæ with high openings, claiming that sphincter action will thus be better preserved. This may be true in certain cases, but the method has not obtained extensive recognition, which may also be said of the treatment by means of cataphoresis (Wallis).

Excision of the entire fistulous tract, followed by immediate suture, may succeed in uncomplicated fistulæ, but the outcome can seldom be depended upon. It can appropriately be tried in tuberculous cases in which the lesion is confined within well-defined limits.

Pedunculated Flaps.—Abrashanoff advocates the closure of various forms of abdominal and other fistulæ by means of pedunculated flaps. A flap, of appropriate size, is cut from a neighboring tissue, such as muscle or fascia, so as to form a loosely fitting plug when inserted into the sinuses, retraction being prevented by a few sutures around the opening. In favorable cases secretion is said to be at once checked and closure soon accomplished.

Coffey's method for the closure of persistent abdominal fecal fistulæ is both ingenious and effective. After calling attention to the high mortality accompanying the ordinary intraperitoneal methods, he describes the following extraperitoneal procedure (Plate I.):

PLATE I.



COFFEY'S METHOD FOR THE CLOSURE OF PERSISTENT ABDOMINAL FECAL FISTULÆ. (ROBERT C. COFFEY, Annals of Surgery, June, 1907.)

Diagrams showing sectional views to illustrate the mechanism of the suturing and drainage: A. Transverse section through the fistula and layers of the abdominal wall. B. Longitudinal section in line of the incision shown in the previous picture. C. Result following closure of artificial anus.

(1) Make a longitudinal incision encircling the fistula, which has been packed with gauze, leaving a small margin of skin around its opening. (2) Carefully separate and turn back, for at least 2 inches, the different layers of the abdominal wall—the skin with its fat, the fascia, and the muscle—leaving the peritoneum. (3) Trim the margin of skin from the projecting fistula and invaginate its edges with a Connell linen suture (Vol. IV., p. 715), the knots being on the inside, and then bring the adjacent tissues over the line of union with catgut, in order to add firmness to the closure. (4) Through-and-through silkworm-gut sutures are inserted along the length of the cutaneous incision, to be tied over rolls of gauze placed along the edges of the wound after the various abdominal layers have been separately united with catgut. (5) A rubber tube is then inserted in one end of the incision, down to the peritoneum, but not reaching to the fistula itself.

If suppuration and leakage from the fistula should occur, as it often does, the pus passes between the layers of the abdominal wall to the tube. Owing to the agglutinative tendency of the parts, closure soon supervenes without disturbance of the lines of suture, as is often observed in the ordinary drainage of an intra-abdominal abscess.

ULCERS.

In large communities the proportion of the working population more or less disabled by crural ulcers is so great that certain cities, for instance, Berlin and Vienna, have established special dispensaries for their treatment, and in the latter clinic alone from 300 to 700 patients present themselves monthly. Unna's paste (Vol. I., p. 301) is extensively used, and has given very satisfactory results, in spite of the fact that most of the cases are ambulatory.

Scarlet-red.—An important principle in the management of chronic ulcerating surfaces is the stimulation of their granulations and of the epithelial-forming powers of their borders. This is accomplished passively by the removal of inhibitory factors, such as sepsis, defective circulation, inefficient general nutrition, etc.; and, actively, by the direct application of various ointments and powders. Under the latter head a dye-stuff, known as *scarlet-red*, has recently assumed considerable prominence, having been introduced by V. Schmieden in 1908. Its stimulating action is very marked, the growth of epithelium being usually rapid and firm, thus contributing to durability of the cicatrix, which is also said to have comparatively little tendency toward contraction.

The best results are obtained when the granulations are clean, red, flat, and "healthy." This condition can usually be obtained by a preliminary treatment of the ulcer upon alternate days with stick silver nitrate and tincture of iodin, together with the ordinary measures of rest, cleanliness, and moderate pressure. The scarlet-red, in the form of an 8 per cent. ointment, is spread upon perforated linen (Davis) and applied to the granulating surface, some inoffensive protecting oint-

ment having previously been smeared upon the skin to within 1 cm. of the border of the ulcer.

Although the danger of producing annoying irritation of the surrounding skin is not great, it nevertheless exists, hence, if the preparation is employed as strong as 8 per cent., as it usually is, it should be discontinued every day or two in favor of some ordinary salve. If too much reaction occur, a weaker ointment must be substituted or the treatment stopped. When indicated, Davis advises the combination of scarlet-red with antiseptic or antisyphilitic ointments, although the utility of this has been disputed.

Nitrate of Silver.—It is asserted by Baruch that a similar stimulating action to that of scarlet-red is obtained by the use of a dusting-

FIG. 3.—THE ABSORPTION TREATMENT OF INFECTED AND SUSPECTED INFECTED WOUNDS IN STERILE SAND-BATH. (Thies.)

powder composed of pulverized silver nitrate, and bolus alba, in the proportion of 1 to 100. The powder is dusted over the ulcer every two to four days, care being taken to wipe superfluous amounts from the surface of the new epithelium, which might otherwise become injured.

Sand-bath.—Thies highly recommends the treatment of ulcers, open abscesses, suppurating wounds, fistulæ, etc., by covering them with sand, upon the principle that finely granular bodies readily absorb fluids by capillary attraction,—the smaller the granules the greater the absorptive power.

The sand should be clean and the particles as smooth and uniform as possible—"from the size of a poppy-seed to that of a hemp-seed."

If it is too fine it cannot be easily removed from the wound. Its sterilization is accomplished by placing a quanitity in a linen bag and boiling for half an hour in a 1 per cent. solution of soda, after which the sack can be hung up to dry. The alkalinity thus produced is of much service, in that it prevents coagulation of the albuminous secretions, which would soon stop absorption.

The sand can be poured over the suppurating surface, or, where an extremity is involved, the part can be placed in a "bath" of the material (Fig. 3). It must be changed more or less frequently, according to the rate of absorption and the character of the discharge.

The duration of the treatments varies with the condition, but the usual length of time is from twelve to fourteen hours daily, although a continuous bath is occasionally desirable in refractory cases. Pain, inflammation, and swelling are said to disappear rapidly under this suction treatment, while healing takes place with unusual promptness. The procedure is especially recommended in burns, ulcers, suppurative infections of the extremities, gangrene, and skin-grafting. It bears a certain relation to the Bier method of cupping, although not depending upon hyperemia for its effectiveness.

The x-ray and other forms of radiant energy, including the Finsen light, blue light, and radium, have not proved to be as efficient in the treatment of ordinary ulcers as was at first hoped. Fairly good results have been obtained, however, in connection with superficial epitheliomatous lesions, especially of the face; with tuberculous ulcers, including lupus; and with certain indolent forms of ulceration, upon which the stimulating effect of the rays seems to exert a more or less beneficial influence. Where repeated or prolonged exposures are necessary, great care must be used with the Röntgen rays and with radium, to avoid the much dreaded burning of the adjacent skin.

Following incautious use of the *x*-ray an exceeding intractable form of ulceration sometimes results (Fig. 4), which has a tendency to eventuate in epithelioma. Such ulcers are extraordinarily indolent, and may persist for years, with little or no tendency toward healing. They are usually surrounded by rough, eczematous and perhaps warty, or at least thickened, skin. After ordinary methods of treatment have failed, as they frequently do, it is often necessary to resort to excision followed by skin-grafting, or even amputation in malignant cases, in order to effect a cure. These unfortunate accidents are becoming, however, quite rare, owing to modern improvements in technic (see chapter on Radiology).

Much attention has been given to the surgical treatment of *x*-ray ulcers by C. A. Porter. Although he strongly recommends a special technic in skin-grafting, the more ordinary methods have given good results in the experience of others.

Heliotherapy.—Considerable work has been done in the treatment of granulating surfaces, particularly old intractable ulcers of the leg, by means of the direct rays of the sun. Jaubert advises a careful

preliminary preparation by means of tincture of iodin, peroxid of hydrogen, moist compresses, etc., and then a daily exposure of the ulcer for from twenty to thirty minutes. Unusually rapid and satisfactory healing is said to take place, due to the production of active hyperemia and to the inhibitive action of sunlight upon bacterial growth. Widmer insists that the new epithelium formed under these circumstances is much superior to that produced by scarlet-red, the approach to normal being sometimes so complete that the cicatrix can scarcely be differentiated from the surrounding skin. Richter affirms that an ordinary

FIG. 4.—X-RAY ULCERATION OF CHEST.

arc-light, with a powerful reflector, is just as efficient as the rays of the sun.

Varicose Ulcers.—Success in the management of this common variety of leg ulcer necessarily depends largely upon the treatment of the accompanying varicose veins. This may be palliative or operative, according to circumstances. In the former category mention must be made of Murphy's "*leg-corset.*" This is carefully made, preferably over a plaster-of-Paris model of the leg, from washable linen or silk, and is provided with light stays to prevent sagging. A "tongue" of stiff, non-wrinkling material closes the gap beneath the laces. Gutta-percha paper is placed over the ulcer, projecting half an inch beyond its borders, and the corset snugly fitted to the limb, being careful that the lacing should not come over the ulcer and that uniform and moder-

ate pressure is secured without undue tightness (Fig. 5). The pressure upon the granulations prevents the occurrence of much secretion, hence it will not be necessary to change the appliance as often as might seem necessary. Murphy considers that the inelastic support thus obtained is much superior to the elasticity of the usual stockings and bandages, to say nothing of the greater durability of the "corset."

Although the **operative treatment of varicose veins** is considered in detail in the chapter on the Vascular System, Vol. V., p. 152, a brief *résumé* will not be out of place in this connection: External cauterization and the intravenous injection of coagulating agents has long been discarded, owing to the inefficiency of the former and the danger of embolism attending the use of the latter. The multiple, subcutaneous ligation of veins, although formerly popular, has proved to be inadequate in all but the mildest cases. The circumcision of certain ulcers, with ligation of the divided veins, is occasionally of service, providing the wound is kept open by packing and allowed to heal by granulation. When the internal saphenous vein is enlarged, with insufficiency of its valves, the simple operation of Trendelenburg may often be employed to advantage if the varicosities are not too numerous and there are not too many anastomotic branches. This consists in ligating or resecting the vein in the upper portion of the thigh, and, perhaps, just above and below the knee.

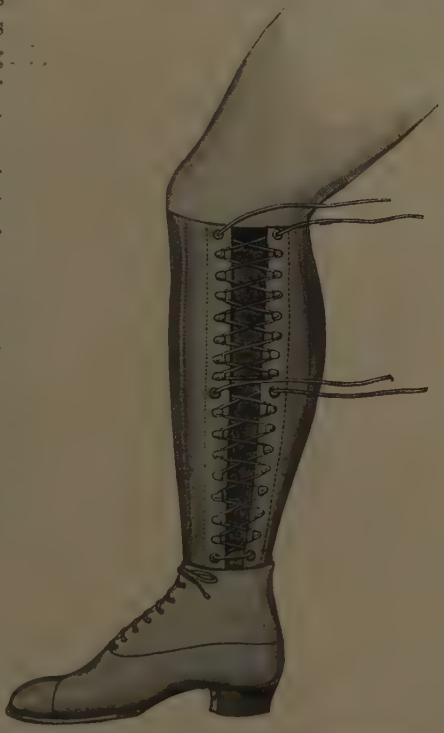


FIG. 5.—MURPHY'S LEG-CORSET FOR THE TREATMENT OF VARICOSE ULCERS.

One of the most effective measures, largely employed by American surgeons, is excision of as many of the enlarged veins as possible, from high up in the thigh to the ankle, using multiple incisions or one or more long, curved, or straight incisions. This sometimes amounts to quite a formidable and tedious operation, especially when the veins are adherent to the skin or embedded in thickened tissues. It is possible, however, in favorable cases to pull out the veins, more or less subcutaneously, through small openings in the skin along their course, according to the method of Charles Mayo.

Basing his procedure upon the fact that the femoral vein is always provided with several valves just below its junction with the saphenous,

Delbet, in 1906, suggested anastomosing the latter vessel with the former, well below the normal opening of the saphenous, so as to obtain valvular support for the column of blood, thus preventing its backing up within the smaller vessel, which has no efficient valves of its own. This apparently rather formidable operation has recently been advocated by others, including Hesse and Coenen, the latter of whom attempted to employ the deep femoral in a similar manner, but without result.

With the idea of aiding the venous circulation by means of muscular contractions, Katzenstein recommends transplanting the varicose saphenous into a kind of tunnel formed by folding the sartorius upon itself. Others transplant the vein beneath the deep fascia.

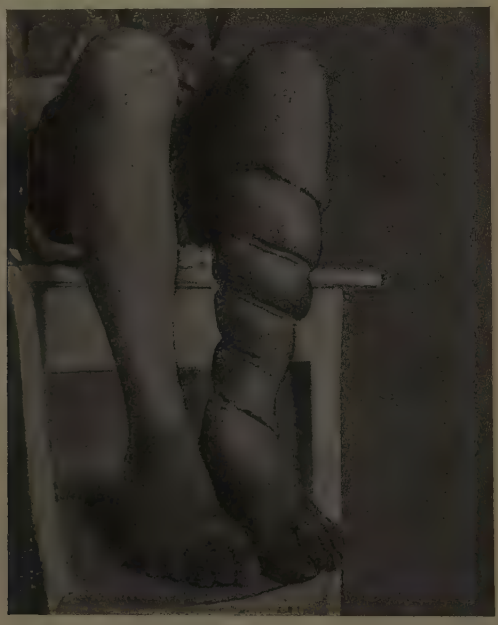


FIG. 6.—RESULT OF SPIRAL INCISION FOR VARICOSE VEINS. (Friedel.)

A recent procedure which has attracted considerable attention is that of Rindfleisch and Friedel. It is especially adapted to severe cases, and consists in encircling the leg with a deep continuous spiral incision, extending completely through the skin to the fascia, from the ankle to the knee. There should be from six to twelve turns, according to the severity of the case, and, after tying the vessels, the wound must be kept open by packing, so as to obtain as deep and firm a cicatrix as possible. Upon this depends the success of the operation. If an ulcer is present, it must lie within the area of the spiral and not below it. The principal objections to this method are the protracted convalescence and the considerable deformity (Fig. 6). The older method of encircling the leg near the knee by a single incision has proved to be in-

adequate, and even two or three spirals, as formerly used, are seldom sufficient.

The various " tropical " ulcers and ulceration accompanying leprosy, pellagra, syphilis, etc., are considered under their appropriate headings.

GANGRENE.

Diabetic Gangrene.—Much of the danger in operating upon diabetics is due not so much to the sugar itself, as to the presence of acetone bodies (acetone, diacetic acid, beta-oxybutyric acid, etc.), which often cause delirium and fatal coma. Blum asserts that the degree of acidosis, and hence in a measure the prognosis, can be determined by the amount of alkali necessary to overcome the acidity of the urine. In mild cases this will approximate 20 gm. of sodium bicarbonate administered internally; in moderately severe cases, 20 to 30 gm.; in severe cases, 50 gm., while in the very bad cases, with coma, alkalinity cannot be produced under any circumstances. The excretion of more than 1 gm. of ammonia in twenty-four hours, according to Wiener, contraindicates serious operative intervention.

Fig. 7.—Electric Apparatus for the Administration of Douches of Dry Hot Air.

Another danger lies in the low resistance of diabetics to infection. This manifests itself, according to DaCosta and Beardsley, in a diminished opsonic power of the blood, which is particularly apparent when acetone bodies are present in quantity. Hence they suggest the feasibility of determining the resistance to infection by means of the opsonic index. In the average case the index was found to be approximately one-third below normal for ordinary pus-forming bacteria. Handmann, however, claims that glycosuria does not diminish the bactericidal properties of the blood, and consequently the low resistance of diabetics to infection must be due to cellular changes.

Douches of *dry, superheated* air have been found to be a valuable adjunct to the treatment of moist diabetic gangrene. The part rapidly becomes desiccated, pain and odor disappear, absorption and bacterial growth are checked, and the debilitated patient may recuperate to a point where amputation of the limb can be done with comparative safety, while in mild cases operation may be rendered unnecessary.

The douches are administered from one-half to three-quarters of an hour daily, in constant or interrupted stream, by means of a specially constructed electric apparatus (Fig. 7). They should be applied to

the living as well as to the dead portions of the limb, thus producing a beneficial active hyperemia. Upon the former a temperature of about 80° to 100° C. should be used, and upon the latter 200° to 300° C., or even as high as 700° C. under some circumstances (Ricard). The results are often extremely satisfactory (Dieulafoy, Willy Meyer), not only in diabetics, but also in selected cases of moist gangrene due to arteriosclerosis and other causes, where immediate operation is not indicated. It may also be employed in frost-bite, particularly in the more chronic cases in anemic individuals; but, if the patient is weak and the condition acute, Bier's passive hyperemia gives better results.

Presenile or Spontaneous Gangrene.—This mysterious and discouraging malady, which attacks individuals of both sexes in or before the prime of life, has recently been the subject of investigation by Leo Buerger, and is said by him to be especially frequent among Polish and Russian Jews. He does not agree with von Winiwarter, that the cause is an obliterating endarteritis, or with Zoege-Manteuffel, that thrombosis follows a primary arteriosclerosis; but advances a new theory, based upon microscopic evidence, in which he attempts to prove that the trouble originates in a stoppage of the circulation by local thrombi of both arteries and veins, which undergo gradual organization. He is not able to state, however, the cause of these thrombi, although he believes syphilis, cold, and the excessive use of tobacco to be important factors. He further suggests that the terms "endarteritis obliterans" and "arteriosclerotic gangrene" be discarded in favor of the designation "obliterating thrombo-angiitis" (Plate II.).

It is probable that Raynaud's disease belongs in this category, and, as emphasized by Sachs, whether the trouble be called erythromelalgia (Weir Mitchell), angiospastic gangrene (Strauss), or acrocyanosis (Barker), the pathologic changes are perhaps identical, as claimed by Buerger.

Hysteric or **neurotic gangrene** is always open to the suspicion of malingering, although this cannot be proved in many instances; and hysteria may, of course, be an accompaniment of any genuine gangrenous affection. In this connection, an instructive case is reported by Dieulafoy, in which amputation of an arm for recurrent multiple gangrenous patches was permitted, the patient subsequently confessing that the lesions were self-inflicted with caustic potash. Various acids are sometimes employed in a similar manner, the fraud being occasionally detected by a characteristic straining of the surrounding parts.

There are, however, undoubtedly cases of genuine spontaneous gangrene of the skin, exclusive of those occurring in connection with typhoid and other diseases, the trouble being variously known as **dermatitis gangrænosa, gangrene zoster, erythema gangrænosum,** etc. They are usually seen in women, although they may occur in men. They begin as erythematous spots, the superficial gangrenous areas following quite suddenly and without marked constitutional symptoms (Plate III.). Although but little is accurately known regarding their causation, nervous and vascular disturbances, combined with a low

PLATE II.

Gangrene of Hand from Ascending Septic Arterial Thrombosis following Slight Wound of End of Middle Finger.

PLATE III.

"Hysteric" Gangrene following Slight Contusion of Back of Hand in a Neurotic Woman.

resistance, are evidently prominent factors. Certain bacilli have been found in the patches by several observers, and it is possible that, in some instances at least, they may be the cause of the disease. Audrey prefers to place most of the blame upon the giving of large quantities of iodids and bromids in susceptible individuals.

Amputation in Gangrene.—The question of *where to amputate in gangrene of an extremity* has given rise to much discussion and difference of opinion. When a definite line of demarcation is present, the decision is usually not difficult; but in many cases of diabetic and spontaneous gangrene it may be hard to arrive at a reliable conclusion, and, in the desire to save as much as possible, too low an amputation may be done, thus risking the integrity of the flaps and perhaps necessitating another and higher operation, to the discouragement of the patient and the endangerment of his life.

In order to relieve this surgical embarrassment, Moskowicz has suggested a procedure for testing the character of the collateral circulation, upon the integrity of which manifestly depends the life of the remaining portion of a gangrenous limb in which the main arterial trunk has been proximally obstructed. This he accomplishes, in the lower extremity, for instance, by rendering the limb bloodless by the application of an Esmarch bandage, from the edge of the gangrenous portion to the upper part of the thigh. At the latter point an Esmarch strap is then applied, tight enough to obstruct the circulation, and the bandage removed, the ischemic limb remaining white and cadaveric in appearance.

The strap is permitted to remain in place for from five to ten minutes and then loosened. Immediately the familiar pinkish hyperemic "blush" begins to travel down the limb, progressing more slowly as it nears the seat of the gangrene, and indicating by its extent the presumable vitality of the tissues. Its lower border, which is often irregular and interrupted by ischemic areas, generally corresponds roughly to the seat of obstruction in the main artery. Under normal conditions but one to two seconds are required for the blush to reach the toes, but, in the presence of pathologic changes, a much longer time is consumed.

The method, although subject to various inaccuracies, nevertheless furnishes a good working basis for operative intervention, especially in dry diabetic, senile, and presenile gangrene; but it should be controlled by similar observations upon the opposite limb and by the usual clinical signs, such as pulse, temperature, etc. It must also be remembered that the phenomenon can easily occur without complete closure of the main artery, and hence does not take into account the possible increase in capacity of the collaterals which might take place after tying the main vessel in the course of an amputation.

When the hyperemia is decided and definite, amputation well within its border may confidently be done; but if the phenomenon is ill-defined considerable caution is requisite, and it is perhaps better at once to go above the knee, as recommended by Haidenhain.

When amputating for diabetic gangrene, especially in bad cases, too much stress cannot be laid upon the *avoidance of unnecessary traumatism.* With this idea in view, certain surgeons have advocated digital compression of the main artery rather than constriction of the limb.

Kausch advises against the use of flaps, cutting straight through the tissues instead, and thus avoiding the production of dead spaces in which disturbing clots may accumulate. Subsequent retraction of the skin is counteracted by extension obtained by means of weights attached to strips of adhesive plaster. Although this extreme view is far from being generally accepted, it may nevertheless occasionally be advisable, especially in the presence of gaseous gangrene of whatever origin, to at least leave the amputation flaps wide open, without sutures, loosely packing the wound with gauze.

Noesske's Vacuum Treatment.—When gangrene is threatened from injury or from freezing, venous stasis is always present, due to thrombosis and to collapse of the vessels and adhesion of their walls. Noesske has elaborated a method of treatment which relieves this stasis, and seems to be successful in maintaining vitality in many instances, especially in cases of partially severed fingers or toes. It has also been used in Raynaud's disease and may possibly have still wider applicability.

In the case of an injured finger, for instance, an incision is made across its tip down to the bone parallel to the nail. A vacuum-cup is then applied, in which is produced a negative pressure corresponding to 12 or 15 c.c. of mercury, the steadiness of the suction being best maintained by connecting the apparatus with a hydrant. In this manner the dark stagnant venous blood is drawn from the tissues and an active arterial flow encouraged. The treatment may be applied for from eight to ten minutes, two or three times daily for about a week if required, the wound being kept open in the mean time by packing it with gauze saturated with camphorated oil. It should be noted, however, that venous stasis, if not too pronounced, is considered by many observers to be a beneficial phenomenon in cases of freezing, maintaining that it should often be encouraged by elastic constriction (Bier), especially in the more chronic cases.

Arteriovenous Anastomosis.—In non-septic gangrene of the foot, due to closure of the main artery, it has been suggested that blood can be carried to the part through the venous system in place of the arterial by anastomosing the femoral artery with the femoral vein. The return circulation may then pass from the deep to the superficial veins through their anastomotic connections, but it is doubtful if the capillaries are ever penetrated. The valves in the veins offer considerable hindrance, as has been proved by experimentation.

The procedure was first carried out by San Martin y Satrustigui in 1902; 58 operations upon 56 cases have been reported, not one of which can be regarded as completely successful, and but very few are even partially so. Hence the outlook for the method is not encouraging, although it cannot be absolutely discarded. Cases suitable for

this treatment are rare, and success, according to Wieting, will depend largely upon the minute care with which they are selected.

The operation should not be attempted in old, weak, or cachectic individuals, or in the presence of sepsis or advanced gangrene, and it should never be done when disease of the veins exists below the point of anastomosis or when the femoral artery is unduly thickened. Arteriosclerosis may occasionally be demonstrated with the *x*-ray (Fig. 8).

The ideal time to intervene is in the pregangrenous stage, before actual mortification has appeared, in order to prevent its occurrence, although a number of later operations have been performed for the purpose of improving nutrition and thus permitting a lower amputation than would otherwise be possible. It is questionable, however, considering all the uncertainties, whether the end in such cases is likely to justify the means.

FIG. 8.—RADIOGRAPH SHOWING ARTERIOSCLEROSIS.

Although the femoral artery and vein are usually selected, well below the entrance of the saphena magna, Payr suggests the use of the deep femoral, so as to avoid interference with any possible circulation which may still remain through the main vessel. His attempt to carry out this idea was, however, unsuccessful. With the same object in view, which seems to have much to recommend it, in theory at least, a number of operators (Wieting, Hadda, etc.) advocate lateral or end-to-side, instead of end-to-end, anastomosis of the femoral vessels. The various attempts which have been made effectively to unite the tibial and the popliteal veins and arteries have failed, owing to disease of the vessels and difficulties in the technic.

All the different ways of accomplishing anastomosis have been tried —end-to-end, end-to-side, side-to-side, invagination, intubation, etc. (see chapter on Vascular Surgery, Vol. V.)—without arriving at a definite conclusion as to which is preferable.

Whatever the method chosen, it must be carried out with the utmost delicacy and skill, in order to avoid the formation of thrombi; and the femoral vein must always be proximally ligated, to prevent the arterial blood from returning immediately toward the heart.

The end-to-end method is the most popular, but there is undoubtedly much to be said in favor of the lateral, without distal ligation of the artery. This has been adopted by Wieting in his later cases, although his first "successful" operation was done by intubating the artery into the vein.

Instead of excising an oval from each vessel, in the side-to-side procedure, Hadda prefers to use a method of his own, in which the vein and artery are first united by sutures, and the partition between them subsequently removed with an instrument made for the purpose. By this means the use of temporary clamps and of sutures exposed to the blood-current is avoided, thus, according to Hadda, materially reducing the chance of thrombosis; but even though a patulous opening is at first obtained, it is very apt to close in the course of time.

A successful anastomosis in a favorable case is immediately followed by the advent of pulsation in the vein and of warmth and color in the affected part, together with the disappearance of pain and numbness. Unfortunately, however, this improvement is too often but temporary, the old symptoms returning and amputation being required in the end, possibly at a somewhat lower level than would otherwise be necessary. If the operation is ever to come into general use there must be a more intelligent selection of cases and an improvement in the technic.

The removal of arterial thrombi and emboli may be attempted when the conditions are favorable, which they usually are not, because of coincident arteriosclerosis and other vascular lesions. A successful case is reported, however, by Mosny and Dumont, who removed a recent embolus of cardiac origin from a healthy artery of the leg, thus preventing a threatened gangrene.

Halstead concludes "that there is but one indication for the appliion of arteriovenous anastomosis in surgery; *i. e.*, in traumatic destruction of a peripheral artery, where end-to-end union of the torn vessel is impossible. In such a case arteriovenous anastomosis might be attempted, and through it we might maintain a sufficient blood-supply to preserve the integrity of the limb until an adequate collateral circulation was established."

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CHAPTER LXXXIX.

THROMBOSIS, EMBOLISM, ERYSIPELAS, AND TETANUS.[1]

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THROMBOSIS.

Thrombo-angiitis Obliterans.—An interesting contribution to the pathology of presenile spontaneous gangrene has been made by Buerger.[2] As is well known, the disease frequently occurs among the Jews, usually in young adults. In some cases the attacks are rather those of an ischemia; the patients complain of indefinite pains in the foot, in the calf of the leg, or in the toes, and particularly a sense of numbness or coldness in unfavorable weather. Some patients complain of rheumatic pains in the legs, others are able to walk but a short distance before the advent of paroxysmal, shooting, cramp-like pains in the leg; others, again, give the typical symptoms of intermittent claudication. These manifestations of ischemia are followed in turn often by erythromelalgia, later by evidences of trophic disturbances, and, finally, by dry gangrene. Heretofore there have been two pathologic explanations: one, the well-known theory of von Winiwarter, who regarded the process as an "endarteritis obliterans," in which the closure of the vessels is attributed to a proliferation of the cellular and fibrous elements in the intima; the other, the theory of von Manteuffel, who attributes the vascular occlusion to a primary arteriosclerosis, in which the obliterative process owes its inception to the formation and extension of parietal white thrombi, caused by desquamation of the endothelial cells in the popliteal artery. Based upon a careful anatomic study of 11 amputated lower extremities, Buerger arrived at the conclusion that the theories of von Winiwarter and von Manteuffel are both fallacious, in that the obliteration is not due primarily, on the one hand, to a proliferation of the intima, or, on the other, to a primary arteriosclerosis, but to the formation of red obliterating thrombi, which eventually become organized, vascularized, and canalized. Most of the larger arteries, and sometimes the veins as well, are obliterated over a large extent of their course. All stages of the process may occur in various vessels or in the same vessel in different parts of its course. The occlusive change begins usually in the larger branches, not in the capillaries or finest arteries, and is an ascending rather than a descending process. Associated with the changes in the wall of the artery

[1] Supplementary to Chapters X., XI., XII. of Vol. I., pp. 418–502.
[2] Amer. Jour. Med. Sci., October, 1908.

itself is a marked periarteritis, which frequently extends to and involves the adjacent nerves. Buerger's findings are summarized as follows:

"Most of the larger arteries and veins of the amputated limbs were found obliterated over a large extent of their course. The obliterative process can be studied at any stage in its development if enough vessels are examined. All stages in the occlusive change may occur in the various vessels of an extremity, or at times in the same vessel in different parts of its course. The occlusion of the vessels is effected by red obturating thrombi; these become organized, vascularized, and canalized. The recent red thrombosis may involve large portions of arteries or veins and is not secondary to the gangrenous process. It occurs even when no gangrene is present.

"Certain changes in the perivascular tissues, in the adventitia, media, and intima, regularly accompany the occluding process. There is moderate thickening of the intima; this is never sufficient to cause marked narrowing of the lumina of the vessels, and does not seem to play any considerable rôle in the genesis of thrombotic process. The media and adventitia show cellular infiltration and vascularization wherever thrombosis has occurred. The intensity of the cellular and vascular change seems in general to depend upon the activity of the organization of the clot; however, in some cases it seems to be sufficiently marked to make it appear that the same agent which calls forth the coagulation of the blood is also effective in producing the mesarterial lesion. The occluding masses frequently terminate abruptly in apparently normal vessels. The changes in the media never extend into the walls of the patent portions of the vessels; usually they terminate before the end of the obturating tissue or thrombus is reached; indeed, the dependence of the medial changes upon the organization of the thrombi can be demonstrated in many places."

As to what causes this extensive thrombosis of the veins and arteries, Buerger is not prepared to give a decisive answer. He is inclined to believe that mechanical conditions, such as slowing of the circulation and arteriosclerotic changes, may be factors, but that some additional agent, be it toxic or otherwise, must be at the same time responsible.

Postoperative Thrombosis.—This subject was very fully discussed in the original chapter on Thrombosis, and, though at that time there was much conjecture as to the source and nature of the thrombotic process, there has been nothing added to our knowledge of the subject that is at all convincing. Surgeons are still divided into two fields—those who regard it as a septic, and those as a non-septic, process. All realize that there may be certain contributory factors, such as gravity, exposure, loss of body heat, hemorrhage, dorsal decubitus, and the like, but to no one of those can be attributed with any degree of positiveness the incidence of thrombosis. To a letter of inquiry to thirty distinguished American surgeons[1] as to the etiology of thrombosis or embolism after an interval appendectomy, there were twenty-one replies; nine

[1] Grant, Jour. Amer. Med. Assoc., 1907, vol. xlvii., p. 567.

attributed the process to infection, and twelve believed the cause to be non-infectious. In order to overcome the effect of sluggish circulation in the postoperative period, Witzel[1] recommends regular breathing exercises before and after operation, urges his patients to move the arms and legs as soon as possible, or if necessary to resort to massage and passive motion as a substitute.

EMBOLISM.

Air Embolism.—In their experiments Blair and McGuigan[2] found that the respiration failed first, and that, if artificial respiration was resorted to immediately, the heart in some cases would resume the normal function. Respiratory failure is in reality due to cardiac embarrassment, there being so little blood in circulation that the respiratory center fails from lack of nutrition. In addition to the usual remedies, they recommend the introduction directly into the right ventricle of adrenalin chlorid (1: 10,000 to 1: 1000), together with a small amount of saline solution. The violent contraction of the muscle that follows the introduction of a concentrated adrenalin solution constitutes a powerful agency in overcoming the embarrassment caused by pressure of the overdistended ventricle. To be effective the treatment must be promptly applied. Artificial respiration should be employed, and, as a last resort, cardiac massage.

Pulmonary Embolism.—There is nothing to be added to our knowledge of the pathogenesis or the symptomatology of this complication. Prior to 1907 the treatment had been purely symptomatic, but in this year Trendelenburg[3] proposed what seemed at first sight a very formidable procedure for its relief, namely, that the pulmonary artery should be exposed, opened, and the embolus removed. This, he writes, is a comparatively safe and simple operation and can be carried out without disturbing the heart's action. Sievers[4] succeeded in removing two large clots from the artery; the operation was begun twenty minutes after the onset of the attack, and the patient died fifteen hours later. The autopsy revealed a dilated heart, but no additional emboli could be found. In a second case[5] the patient survived the operation thirty-seven hours, and death was due to a postoperative hemorrhage from the internal mammary artery. In a third case Krüger[6] operated, according to Trendelenburg's technic, eleven days after a herniorrhaphy. The pulmonary artery was opened, the thrombus exposed and only partially removed when the heart stopped beating. It responded to cardiac massage, and a large embolus was removed. The patient died on the sixteenth day; small emboli were found in the pulmonary artery, as well as several in the lung, and fresh pericarditis and an empyema.

[1] Deut. Zeit. Chir., vol. lxxxv., p. 228.
[2] Annals of Surg., October, 1910, p. 471.
[3] Deut. Zeit. Chir., 1907, No. 44.
[4] Ibid., 1908, xciii., 283.
[5] Trendelenburg, Deut. Zeit. Chir., 1908, Bd. xcv.
[6] Zentralbl. Chir., 1909, No. 21, 757.

Although there have been no recoveries, these cases serve to demonstrate that from the technical point of view the operation is quite feasible. Even in apparently hopeless cases the surgeon should not hesitate, according to Trendelenburg, at least to make the effort to save the patient's life, especially as in most cases the situation is otherwise hopeless. Success will only be obtained when the condition is promptly recognized and operation resorted to without delay. The pericardium is exposed by reflecting an osteoplastic flap and opened at the level of the third rib. Traction on a tube around the artery will suffice to interrupt the blood-current. The vessel is opened and the embolus removed, if necessary, using a pair of curved forceps to explore the artery and its branches. The arterial wound is temporarily closed with a clamp and the constricting tube released. The wound in the artery is sutured with fine silk, the wound in the pericardium closed, and the flap replaced.

By some, thrombosis is attributed to damage to the stomach and intestines, which favors the entrance of bacteria and toxins into the blood, and, as a prophylactic, the institution of such remedies as will favor the restoration of the activity of the stomach and intestines is recommended. Ranzi,[1] in his study of the records of 6871 cases from the Vienna Surgical Clinic, discovered 57 instances of pulmonary complications of embolic origin (0.82 per cent.). Of 3000 operations in Königsburg, there was postoperative pulmonary embolism in 0.7 per cent. of the cases. In operations upon the abdominal cavity alone, the percentage is in the neighborhood of 1 per cent. Among other things, Ranzi considers degeneration of the heart muscle and the quantity of the anesthetic as important factors, and recommends breathing exercises, elevation of the chest to the sitting posture, and massage and passive movements to stimulate the circulation of the extremities. The incidence of embolism as a complication may be influenced, according to the various theories which have been advanced, by the early administration of laxatives, by the administration of saline solution to make up for the loss of blood, and to dilute the blood by the use of strophanthin and by such remedies as have already been mentioned to overcome the influence of a sluggish circulation. As a certain number of cases are undoubtedly of infectious origin, rigid asepsis should be regarded as one of the most effective preventive measures.

ERYSIPELAS.

Etiology and Pathology.—Panton and Adams,[2] in a very excellent paper, have investigated certain disputed points in the etiology of erysipelas and the allied inflammatory lesions, cellulitis and lymphangitis.

(1) They conclude, from their experiments, that erysipelas is an acute inflammation of the epidermis, due to the presence of one of the organisms of the streptococcus class, of which the Streptococcus py-

[1] Archiv. klin. Chir., vol. lxxxvii., p. 380.
[2] Lancet, October 9, 1909, p. 1065.

ogenes is the most frequent example. It may, however, be produced by a variety of organisms, and these organisms are capable of producing other diseases in other parts of the body.

(2) The certainty of diagnosis of erysipelas rests on three groups of phenomena—the well-known physical signs, constitutional disturbance, and the local spread of the erythema with its growing margin. In erysipelas there is invariably acute inflammation of the epidermis itself.

(3) In cellulitis deeper tissues are involved, and the epidermis escapes, but the variety of organisms and their cultural characteristics are not different.

(4) Lymphangitis appears to be caused by an organism of different type and less severity, and hence either glandular involvement or the presence of a staphylococcus would favor the diagnosis of lymphangitis.

(5) Erysipelas is commonly considered to be more infectious than cellulitis, and this may be due to the more superficial nature of the inflammation, and to the desquamation which accompanies the former condition, but the danger of infection is the danger of transferring streptococcus from one patient to another, a sufficiently serious event, of which perhaps the least serious effect is the production of erysipelas.

(6) At St. Thomas' Hospital, London, the separation of erysipelatous cases from the septic cases had no effect in lessening the occurrence of erysipelas in these septic wards. The danger of transmitted infection depends on the presence of discharges from a streptococcal wound, rather than upon the risk of contagion from such a lesion as facial erysipelas, which is practically free from discharge. Two cases of doubtful erythema were admitted direct to the special erysipelas ward, and the subsequent course of these cases proved that they were not suffering from erysipelas on admission, nor did they contract it, though exposed to infection, at any rate by aërial contagion.

Diagnosis.—Milian[1] describes three signs which he believes to be constant and pathognomonic:

(1) *The Sign of Centrifugal Maximum.*—The most marked lesions are always situated at a spot at some distance from the starting-point on the periphery of the patch, as are also the swelling and pain on pressure. This sign is useful in distinguishing erysipelas from inflammatory troubles, dacryocystitis, dental abscess, parotiditis, or mumps.

(2) *The Ear Sign.*—Owing to the close adherence of the dermis and perichondrium, and the absence of subcutaneous tissue in the ear, inflammatory processes stop short at the periphery, whereas erysipelas, being a dermatitis, spreads in the thickness of the skin itself, invading that of the ear as it does the skin of any other part.

(3) *The Pain Sign.*—The erysipelatous patch is invariably exceedingly painful. The patient invariably makes a grimace and shrinks when it is pressed, whereas in acute eczema and ophthalmic zona the parts are not so tender on pressure. In dental abscess and dacryo-

[1] Med. Presse and Circular, 1908.

cystitis, however, the affections are both painful and tender, but in a different way.

Afebrile Erysipelas.—No mention was made in the previous volume of the fact that erysipelas may exist without the occurrence of fever. Czhlarz[1] records 29 afebrile cases among 324, and Macauley[2] records 2 fatal cases with an afebrile course.

Erysipelas in the Child.—It is important to bear in mind that erysipelas in the child, and especially in the infant, rarely shows the characteristic local and general symptoms found in the adult. Milhit and Stevenson[3] call attention to two irregular manifestations of this disease in the very young, namely, a localized edema and multiple abscesses. But careful examination will detect a faint rosy line at the periphery or elsewhere on the skin and desquamating patches. These are sufficient, even in the absence of fever, to diagnose erysipelas, and the rapid evolution of the disease and the presence of streptococci in the serous exudate will afford further confirmation.

Erysipelas in the Aged.—Schlesinger[4] states that 288 (10.8 per cent.) of his 2664 cases of erysipelas were in persons over sixty years of age. In 25 per cent. of these the disease terminated fatally. The erysipelas attacked the face almost invariably, and complications frequently occurred. Abscesses and phlegmons, suppurative venous thrombosis, and gangrenous processes were frequent; kidney complications were repeatedly encountered, especially an acute hemorrhagic process subsiding with the infection; heart disturbances were rare; nervous symptoms, especially delirium, were frequent.

Treatment.—There has been but little added to the therapeutics of erysipelas. A number of Italian writers advocate the use of diphtheria antitoxin, both locally and hypodermically; Migliacci[5] believes that it acts favorably by inducing a leukocytosis, thus promoting phagocytosis. Carbolic acid, followed by alcohol and tincture of iodin painted on the affected surface, magnesium sulphate solution and ichthyol, seem to have many advocates.

Urotropin internally has been recommended. Binz[6] uses an ointment containing 15 per cent. of chlorinated lime ($CaOCl_2$). Schlesinger, with an experience of 2664 cases, uses compresses wet with Burrow's solution (5 parts alum and 25 parts of lead acetate in 500 parts water) or 60 per cent. alcohol. He warns against morphin in elderly persons. Heat is strongly recommended by Ritter.[7] He applies a jet of superheated air to the erysipelatous patch for half an hour two or three times a day. A hot flat-iron may also be used, applied for ten or fifteen minutes three times a day.

The ideal treatment of erysipelas is, of course, the use of some specific agent directed against the Streptococcus pyogenes. The antistreptococcic serum has been extensively used in the past with vary-

[1] Berlin. klin. Woch., 1911, xlviii.
[2] Berlin. Med. Jour., 1910, i., 495.
[3] Prog. Med., January 28, 1911.
[4] Med. Klin., August, 15, 1909.
[5] Gaz. d. Ospedali, Sept. 16, 1909.
[6] Berlin. klin. Woch., Nov. 1, 1909.
[7] Münch. med. Woch., May 24, 1910.

ing results, mostly disappointing. A bacteremia in erysipelas is quite rare, the constitutional symptoms are no doubt due to toxins and the local signs to the growth of the streptococci in the lymph-spaces. Any agent, therefore, which would control the growth of the streptococcus in the skin would terminate the constitutional reaction. Ross and Johnson,[1] from a study of 16 cases, state that "the opsonic power of the blood is low during the acute process of the disease and whenever more or less rapid spread is manifest; again, the subsidence of such symptoms as malaise, mental unrest, or apathy; pain and tenderness and the localization of the inflammatory areas are closely associated with an increased immunity, as evidenced by the rise of opsonic power." They believe that a vaccine prepared from the Streptococcus erysipelatis, properly administered, exercises a specific and controlling influence on the course of the disease, preventing its spread, lessening its severity, and hastening recovery.

Erysipeloid.—This infection, an erythematous inflammation, is most commonly observed on the hands of those engaged in handling putrefactive animal products, especially fish, shell-fish, meats, poultry, and cheese. It is adequately described in Vol. I., p. 476. Jopson[2] observed 2 cases on the hands of scientific investigators engaged in studies of comparative and experimental pathology. He recommends lead-water and laudanum and ichthyol as comfortable dressings, and believes that tincture of iodin, painted around and beyond the advancing margin, may check the spread of the condition.

TETANUS.

Cephalic Tetanus.—Our attention has been called to cephalic or "Kopftetanus" by the controversy which has arisen regarding its pathogenesis. This is a peculiar form of tetanus, which is usually attributed to bacterial infection of a wound on the face, forehead, or scalp, and which is generally accompanied by paralysis of one or more of the cranial motor nerves, and in a few cases by hyperesthesia or anesthesia in the area of the facial nerve, in addition to the usual tetanic spasms, which, in this variety, are localized in the muscles of the lower jaw and neck, particularly those connected with respiration and deglutition. Out of 104 cases of cephalic tetanus collected by Ross[3] paralysis of one of the cranial motor nerves was present in 81 instances, while in the other 23 cases the tetanus was in every instance the result of a wound on the face. The mortality from these cases of "kopftetanus" was found to be lower than that from ordinary tetanus, being only 54.4 per cent.

There has been great divergence of opinion regarding both the origin and character of the facial paralysis which is so important a feature of this form of tetanus. It is now generally held, especially by Brunner and Klemm, who have experimented on animals, and Friedländer, that it is of peripheral origin. The latter author[4] has also

[1] Jour. Amer. Med. Assoc., 1909, lii., 747. [2] Amer. Jour. Med. Sci., 1908.
[3] Edinburgh Med. Jour., March, 1906. [4] Deut. med. Woch., July 11, 1907.

come to the conclusion that the essential lesion is a neuritis without any question, and has thus accounted for the occasional absence of the paralysis. He believes that inflammation of the nerve-sheaths begins near the site of the wound and travels centripetally, but without giving rise to any special symptoms until it begins to affect the nerves inside the Fallopian aqueduct or canal, where the pressure of the surrounding exudate causes immediate paralysis of the nerve. Therefore, paralysis of the facial muscles is not a constant accompaniment of kopftetanus, but only occurs when the inflammatory process has reached the Fallopian canal.

Postoperative and Catgut Tetanus.—Since the mortality from so-called postoperative tetanus has been very high, the exact nature and origin of the disease has been a matter of much discussion. Richardson[1] has collected 21 cases of tetanus following operations, in all of which it was ascertained that catgut had been employed. He has, however, found no positive evidence to condemn the use of catgut, for, after examination of the catgut used at 14 of these operations, bacilli were found in only 4 cases, and it was impossible to cause tetanus in animals inoculated with the cultures. From a careful study of diseases prevalent among sheep, scientists have found that they are subject to a group of diseases which can scarcely be distinguished from tetanus; and it, therefore, seems very probable that, instead of being true tetanus, the so-called postoperative tetanus is one of the other diseases so common among sheep. Kleinertz[2] has collected 33 cases of catgut tetanus from German literature, and estimates the mortality from this form of tetanus as many hundred.

Postoperative tetanus has been found responsible for a considerable number of deaths in apparently clean surgical cases, in which the technic was faultless and the material used thoroughly sterile. The cause of the infection must lie outside of the operative act itself. Matas[3] has made an important contribution toward the solving of this rather baffling problem. He believes that certain forms of postoperative tetanus, especially those following operations on the intestines and other regions liable to fecal contact, are caused by the contamination of the alimentary canal with living tetanus bacilli, which have entered the system in *raw* uncooked vegetables and fruits, cultivated in fertilized soil. In all such cases which have come under Matas' observation the patients have eaten these vegetables only a few hours prior to the operation. He, therefore, feels that certain dietetic measures will make the prognosis for this most deadly form of the infection much more favorable, and he recommends the following antitetanic preparation for all operations on parts where fecal contamination cannot be avoided: (*a*) Purgation three days before the operation; (*b*) the suppression of all raw, uncooked food, especially green vegetables, berries, and other fruit (for the same period of time before the operation). When such dietetic precautions are impossible, as they

[1] Brit. Med. Jour., April 17, 1909.
[2] Berlin. klin. Woch., Sept. 6, 1909.
[3] Trans. Amer. Surg. Assoc., 1909.

are in emergency cases, a subcutaneous injection of 10 c.c. of tetanus antitoxin is advised, to be administered while the patient is still under the anesthetic.

Fourth of July Tetanus.—Within the last few years there has been a marked reduction in the number of injuries resulting from Fourth of July celebrations, and consequently the number of cases of tetanus following these accidents has decreased proportionately. In 1911 there were but 18 cases of tetanus reported as a result of such injuries, a great improvement when we consider that there were 72 cases in 1910, 150 cases in 1909, 76 in 1908, and 73 cases in 1907. The year 1911, however, marks not only a decrease in the number of these cases of tetanus, but in the mortality as well, for we find that, of the 18 cases of tetanus reported this year, only 55 per cent. were fatal, while in 1910 the mortality was 93 per cent., and in 1909, 84 per cent. The following table shows the relation of the duration of the disease to the mortality as revealed by the statistics of the 18 cases reported this year:

	Cases.	Recovered.	Died.
Two days	4		4
Three days	2		2
Four days	1		1
Seven days	2		2
Eight days	1		1
Nine days	1	1	
Thirty-two days	1	1	
	6		

The average length of the incubation period was about eight days. While most of the cases could be attributed to the use of fireworks, a few were due to wounds caused by nails, splinters, etc., and to crushing injuries.

Too much credit cannot be given the Journal of the American Medical Association for the campaign for a safe and sane celebration on Independence Day, inaugurated by the Journal nine years ago, the influence of which, through the assistance of the daily press and the enlightenment of civic bodies, is now felt throughout the land. The number of injuries has been reduced from 5623 each year to 1603; the total deaths from 466 to 57; and deaths from lockjaw from 405 to 10!

Treatment.—While tetanus toxin has proved of greater value as a prophylactic agent, neglect to use tetanus antitoxin as a curative agent, in the light of our present knowledge, is unwarranted. While the mortality is still high, a larger number of cases recover in which antitoxin has been used. Hoffmann[1] found the mortality 58 per cent. in 13 cases where the antitoxin was used subcutaneously, and 12.5 per cent. in 16 cases after intradural injections. In the former chapter (Vol. I., p. 500) the following views were expressed as to the active treatment of tetanus:

In order to prevent the action of the toxin spreading to hitherto unaffected tissues we resort to the administration of one or two or more of the so-called antidotes—antitoxin, carbolic acid, or brain emulsion.

[1] Beit. klin. Chir., Bd. 55.

The question will arise as to which of these remedies should be used, and whether one or more than one should be tried. Antitoxin should be used invariably unless unavailable; under these circumstances, one must resort to Baccelli's or to the carbolic acid treatment. If the case is a very severe one, and does not respond promptly to antitoxin, one should not hesitate to resort to carbolic acid or brain emulsion; of course, without interruption of the serum therapy. As to the method of administering the antitoxin: (1) 10 to 20 c.c. should be injected into the tissues about the wound; (2) 10 to 20 c.c. should be injected intravenously and into the muscles, in order to neutralize the circulating toxins; (3) intraneural injections, as near the cord as possible, into the nerves of both upper and lower extremities (brachial plexus, sciatic, and anterior crural nerves); (4) as suggested by Porter, an immunizing or neutralizing injection may be given at the highest level which the severity of the symptoms appears to justify, directly into the cord, as advocated by Rogers, or into the higher motor nerves, such as the hypoglossal and spinal accessory, as advocated by Porter; (5) if the injection directly into the spinal cord at a higher level is omitted, it might be well to carry out Rogers' suggestion, and inject the antitoxin *into*, not around, the nerves of the cauda equina.

In the administration of antitoxin one should always be mindful of the fact that the serum is absolutely harmless, and can be used repeatedly and in large quantities without any untoward effect. The doses, therefore, should be liberal, and should be repeated daily or twice daily if necessary.

Observations of the intervening years would seem to indicate a revision of this plan of procedure in certain details. I still maintain that antitoxin should be used invariably unless unavailable, in which case the Baccelli or carbolic acid treatment should be substituted. As to the methods of administering the antitetanic serum, I am disposed to give preference to the intraspinal injections over the subcutaneous or intravenous methods, and while theoretically I advocated the intraneural injections as near the cord as possible into the nerves of both upper and lower extremities (brachial plexus, sciatic, and anterior crural nerves), I have not been able to find sufficient data to warrant endorsement of this practice. I feel justified, however, to recommend more forcibly now than in the original chapter, in cases in which the convulsions were frequent and violent and not otherwise favorably influenced, the use of magnesium sulphate solely as a symptomatic remedy. While appreciating its dangers (depression or paralysis of respiratory center), its extraordinary influence over muscular spasm has no doubt determined the favorable outcome in not an inconsiderable number of cases. There is no reason to believe the original dosage should be modified—1 c.c. of a 25 per cent. solution for every 25 pounds body-weight in children and for every 20 pounds in adult males. Should signs of respiratory failure manifest themselves, means for maintaining artificial respiration should be at hand, and the spinal canal should be washed out with saline solution. Through personal communication and from

literature a number of isolated cases of recovery have been brought to my attention.

Prophylaxis.—Emphasis cannot be laid too positively upon the importance of the routine use of tetanus antitoxin in all wounds of the character in which the tetanus bacillus is prone to develop. In addition to gunshot wounds, punctured wounds, and blank-cartridge wounds, we should include crushing and lacerated injuries of the body surface, especially those in which dirt has been ground into the tissues. In surgical practice the routine use of antitoxin in these cases should be regarded as imperative, and the surgeon who does not enforce this rule, whether in his private or his hospital practice, not only negatively but positively neglects his patient's welfare. In the original chapter (Vol. I., p. 488) attention was called to the great immunizing power of tetanus antitoxin, and the accumulated evidence of the intervening years serves only to confirm the opinion as to its value as a prophylactic agent. In a special investigation made by the American Medical Association they were unable to discover a single case in which a person who has received an immunized dose subsequently developed tetanus.

To secure the best results the antitoxin should be given as soon after the injury as possible, the longer the delay the greater the opportunity for the disease to become established. Even where it has been given too late to prevent the disease, there is reason to believe that the prognosis is more favorable. Suter[1] collected 700 cases in which there was but one slight attack of tetanus when antitoxin had been used. In 1909 the Société de Chirurgie reported that in the last seven years there had been but 11 cases of tetanus in the hospitals of Paris, all of them being in persons who had not received the customary preventive dose, the routine practice there after all street accidents.[2]

The following rules should be enforced in every emergency station:

(1) Freely incise every wound.

(2) Carefully and thoroughly remove from the wound every particle of foreign matter.

(3) Cauterize the wound thoroughly with a 25 per cent. solution of phenol or carbolic acid.

(4) Apply a loose wet boric acid dressing.

(5) Inject subcutaneously 1500 units of antitetanic serum.

(6) In no case should the wound be closed. It should be allowed to heal by granulation. The dressing and packing should be removed every day.

With regards to the incidence of Fourth of July tetanus, additional prophylactic measures have been resorted to through proper legislative methods, aiming either to restrict or, preferably, to prohibit the use of explosives on that day. In cities with prohibitory laws tetanus has been altogether eliminated or reduced in frequency to an extraordinary degree. In 1909 there were no deaths from tetanus in Chicago, with a population of two and a quarter millions—a victory for enlightened legislation and modern prophylaxis.

[1] Archiv. klin. Chir., Bd. 52. [2] Jour. Amer. Med. Assoc., vol. liii., p. 955.

CHAPTER XC.

DISEASES CAUSED BY SPECIAL INFECTIONS.[1]

By Charles Harrison Frazier, M. D.,
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ANTHRAX.

In 1905 Legge[2] wrote a complete paper upon Industrial Anthrax, mostly from the experience of cases occurring in Great Britain. In 1909 Page[3] brought the subject to date. The total cases of industrial anthrax in Great Britain from 1899 to 1907 from all causes was 452. Of these 114 died, giving a percentage mortality of 25.2. These occurred in persons manipulating wool and worsted (40 per cent.), bristles and horsehair (20 per cent.), hides and skins (30 per cent.), and in those engaged in various industries, such as harness, cutlery, boot-making, rag-sorting, etc. (10 per cent.).

During the same period Page estimated that there were more than half as many more (non-industrial cases) in those who come in contact with animals infected with anthrax, as shepherds, farmers, veterinary surgeons, butchers, etc.; those infected by contact with workers in infected materials; and those infected by miscellaneous causes, such as the transmission of infection by flies, postmortem examinations, etc.

Anthrax is slightly more common in Germany than in England, and much more so in Italy. In all countries except Great Britain agricultural anthrax is the most common, and consequently there is a close relation between the number of cases of human and animal anthrax. There are no statistics available for the United States.

With the exception of about 5 per cent. the anthrax pustule occurs on the head, face, neck, or upper extremity.

Treatment.—At the present time the treatment of anthrax is not satisfactory. The various methods of treatment mentioned in Vol. I., p. 509, are still in vogue.

Thorough cauterization of the pustule and the administration of Sclavo's serum seems to be the only treatment worth while. The collective statistics of the results of serum treatment are most discouraging, but careful analysis reveals many advanced, even moribund, cases in which it has been used. In such cases there is no chance to stimulate resistance, and the patient is doomed, no matter what the treatment; if they are excluded, the mortality of the disease decreases to something below 10 per cent.

[1] Supplementary to Chapter XIII., Vol. I., p. 503.
[2] Lancet, March 18, 1905, p. 589.
[3] Jour. of Hyg., 1909, ix., 279.

Earlier diagnosis, and the use of large doses of the serum must be tried, before the serum should be abandoned. The serum may be obtained from Elia Coli of Siena, Italy, in 10 c.c. tubes.

It should be mentioned that several writers strongly condemn any operative interference. Thus, Creite[1] reports 13 cases, with 12 recoveries, in which local applications of aluminum acetate were used, and Ferguson[2] successfully treated one patient with Sclavo's serum alone.

Prophylaxis.—The safeguarding of workers in materials carrying anthrax spores has attracted considerable attention. Both Legge and Page discuss the subject in great detail. In the case of horse-hair and bristles it seems established that steam disinfection greatly diminishes the risk, but is not effective in destroying all spores. The immersion of the raw material in cyllin (1: 100), a coal-tar derivative, is recommended by Page as the best method of disinfection known at present. As the chief source of infection is the nails, they should be routinely scrubbed with a brush and disinfectant. The use of overalls, gloves, respirators, etc., is also very important. In the case of hides, Ponder[3] proposes a method which he terms the "formic-mercury process," which has proved highly efficient by animal experiments, and which, in the opinion of practical tanners, improves the leather. The hides are soaked in formic acid and perchlorid of mercury and then "salted" with sodium chlorid.

An important observation is that made by Eurich,[4] who states that the blood-stained wool and hair are the actual carriers of the germs of anthrax, and not the dust found in the wool, as formerly believed; but the dust may become dangerous by reason of its admixture with scales of dried blood derived from the tainted hairs. He examined for anthrax nearly 600 samples of wool, hair, and dust—not blood-stained—with negative results, while 139 blood-stained specimens were tested, with the result that anthrax bacilli (often in great numbers) were found in 14.4 per cent.

GLANDERS.

Etiology.—"That one case in every ten of chronic human glanders causes or is caused by another human case is a fact not sufficiently known to the medical profession" (Robins[5]). This statement is of the greatest importance, especially as it was stated in Vol. I., p. 513, that direct transmission from man to man was very rare. The statement holds true also in acute cases. Another fact that should be emphasized is the danger to those engaged in laboratory work with Bacillus mallei. Bevan[6] refers to several deaths among laboratory workers from glanders. In 1908 Dr. T. M. Wilson, of Chicago, lost his life from glanders while endeavoring to produce a serum against

[1] Deut. med. Woch., 1908, xxxiii., No. 50.
[2] Brit. Med. Jour., 1911, ii., 103.
[3] Lancet, 1911, ii.,
[4] Ibid., Nov., 14, 1908, p. 454.
[5] Studies from Roy. Victoria Hosp., 1906, vol. ii., No. 1.
[6] Jour. Amer. Med. Assoc., 1908, l., 1599.

this disease. The marked penetrative power of the bacillus makes contact with it exceedingly dangerous.

Pathology.—The following description of the pathology of glanders is based upon an experimental study by Duval and White,[1] and supplements the description in Vol. I., p. 513.

The glanders bacillus and its toxins produce three distinct types of change in the tissues—exudative, proliferative, and degenerative—the determining factor being the degree of virulence of the culture. The highly virulent culture causes primary necrosis and disintegration of the tissue, followed by the invasion of the injured area by polymorphonuclear leukocytes. The bacilli of moderate virulence give rise to a primary lesion of an acute, inflammatory nature in which the cells show no evidence of necrosis or disintegration. The attenuated bacilli produce primary tissue proliferation with the formation of epithelioid and giant cells. The lesion, whether exudative or proliferative, is focal in character.

The acute cases develop exudative and degenerative lesions, the tissue cells being broken up by the virulent toxin, and the broken-down nuclei form the degenerative " chromatic masses." The chronic cases show the proliferative changes, the weak toxin inducing a histologic appearance resembling tuberculosis, except that the picture of acute virulent tuberculosis corresponds to the appearance of the weak glanders infection and vice versâ.

Acute Glanders.—The symptomatology has been previously described (Vol. I., p. 514). To this may be added Pilcher's observation[2] that there is extreme prostration out of proportion to the physical signs, early signs of muscle pain, and early involvement of the various large joints. Meyer and Crolin[3] state that when, with a more or less septic condition, there appears on the skin indurated, painful, reddened areas with soft centers, with less tendency to rupture than ordinary abscesses, and which, when opened discharge a thin serosanguineous material, the resulting ulcer having a necrotic base, usually involving muscle and with no tendency to heal, glanders should be thought of, and all the means at our disposal should be made use of in aiding us to make a correct diagnosis.

Chronic Glanders.—A study of this variety was made some years ago by Robins,[4] which was based upon 156 cases collected from the literature, and stands as a unique and perfect monograph upon the subject. He distinguishes as chronic those cases which had a duration of six weeks or more. He notes " that rashes, phelgmon, and lymphadenitis each occur in about one-third of the cases; that multiple abscesses occur in 80 per cent., and nasal involvement, which is twice as common as ocular or buccal lesions, in about 40 per cent.; that clinical signs referable to the lungs seem to occur in only 25 per cent. of

[1] Trans. Assoc. Amer. Phys., 1907, xxii., 398.
[2] Annals of Surg., 1907, xlv., 444.
[3] Jour. Amer. Med. Assoc., 1908, l., 1593.
[4] Loc. cit.

the cases, though focal pulmonary lesions exist in 70 per cent. of the autopsies; that localized purulent pachymeningitis is by far the most common intracranial lesion, and that involvement of the abdominal organs rarely causes characteristic manifestations."

The duration of the cases varied from six weeks to fifteen years and averaged fourteen and one-half months.

Diagnosis.—Glanders is recognized by the clinical symptoms, by the macroscopic appearance of the pus, and by microscopic examination for the Bacillus mallei; by the mallein test, the agglutination test, and the Strauss reaction. It should be remembered that many cases are not recognized at all, that many are mistaken for other diseases until too late, and, what is of still greater importance, that the disease is highly fatal and may be conveyed from person to person.

The clinical symptoms have been referred to in Vol. I., and amplified above; suffice it to say, that the mere fact of the patient's occupation bringing him in contact with sick horses should suggest the possibility of the disease whenever an obscure septicemia or pyemia is detected, a chronic inflammatory lesion of the oral or nasal mucosa exists, or an inflammatory mass presents itself in the subcutaneous or muscular tissues. As a rule, leukocytosis is absent. Glanders has been mistaken for small-pox, syphilis, varicella, tuberculosis, impetigo, anthrax, erythema nodosum, typhoid fever, typhus fever, acute rheumatism, pneumonia, pyemia, and septicemia. The pus from the abscess is usually pink or gray rather than yellow, and is viscid and glairy.

The morphology and cultural characteristics of the Bacillus mallei are well known, and the smears should be made on glycerin-agar. Bernstein and Carling[1] state that the organism is actively motile, an observation contrary to current opinion, and also that the virulence of the culture does not subside on culture-media.

Mallein Test.—Ten to 15 minims of mallein should be injected, and in a few hours the reaction, if positive, will appear. This is marked by fever and pain at the site of injection, and often at the site of the lesion; an edematous swelling will appear also at the site of injection. Mallein has not been generally used in human cases, but there is no reason why it should not, especially in suspected or chronic cases.

v. Pirquet Test.—The method of v. Pirquet has been used in the diagnosis of glanders by Martel[2] in several cases of human glanders, although Valee, in 1907, suggested its use in the horse. Mallein, diluted with carbolic acid solution (1:200), in various dilutions, was inoculated into the suspected cases and in 10 controls. The former showed a positive, inflammatory reaction in twenty-four hours, and reached a maximum in two to three days. The controls were all negative.

Agglutination Test.—First suggested by McFadyean in 1896, and extensively employed since 1905. This test is of value in recent infections, but is variable and may fail in chronic cases. In many of the

[1] Brit. Med. Jour., 1909, i., 319.
[2] Berlin. klin. Woch., 1908, xlv., 451.

recent cases of glanders reported in the literature the test was of signal value; in a few it failed. The dilution should be 1: 100 and upward to be positive. In 1909, Schütz and Schubert[1] perfected the complement fixation test, and recommended it as the most reliable method for the diagnosis of glanders which we have at our command at the present time.

Strauss Reaction.—A loopful of the glycerin-agar culture of the suspected organism is introduced into the peritoneal cavity of the guinea-pig. When the reaction is positive a marked orchitis develops, and death usually occurs in two or three days. The lesion consists of a suppurative inflammation of the tunica vaginalis, between the layers of which is a purulent exudate, and from which the bacillus may be recovered. No dependence can be placed on a negative result.

Treatment.—There has been but little added to our methods of combating this very fatal disease. A few cases, mostly of the chronic type, are on record of treatment by mallein, but nothing definite is known. Bristow and White[2] report the use of an autogenous vaccine, fifteen injections being given with an average interval of seven days between doses; 10,000,000 was the initial, and 300,000,000 the final dose. The patient, who was suffering from chronic glanders with symptoms of pyemia, recovered.

ACTINOMYCOSIS.

Etiology.—There is still considerable confusion as to the exact organism causing actinomycosis. Wright limits the term actinomyces to those strains which produce colonies of club-shaped organisms in animal tissues, the identical organism described in 1891 by Wolff and Israel. Shiota[3] distinguishes two types—one, and the more common, that described by Wright, and the other that described by Bostroem. Recently Peklo[4] has studied some organisms found in the root tubercles of the alder and sweet gale; he concludes that they belong to the actinomyces group. He furthermore showed that, by the use of analogous culture-media, cultures of the tubercle bacillus developed a remarkable morphologic similarity to the growths from the alder nodules. These observations are especially interesting, as many cases of actinomycosis are reported as dying of pulmonary tuberculosis, and as Maier[5] has reported a case of actinomycosis greatly improved by the use of tuberculin. Shiota, however, used tuberculin in 2 cases of abdominal actinomycosis without benefit. Lord[6] reports the finding of organisms having the morphology and staining reaction of actinomyces in smear preparations (11 cases), and in serial sections (5 cases) of the contents of carious teeth from individuals without actinomycosis.

[1] Archiv. Wissensch. u. Prak. Tier., 1909, Bd. 35, p. 44.
[2] New York State Jour. Med., 1910, x., 236.
[3] Deut. Zeit. Chir., 1909, cl., 287.
[4] Centralbl. Bact., 1910, ii., 451.
[5] Beit. klin. Chir., 1909, lxiii., 472.
[6] Boston Med. and Surg. Jour., 1910, clxiii., 82.

This finding is important, as lack of free drainage of a tooth cavity, whether arising spontaneously or as the result of filling an incompletely sterilized tooth, may be regarded as favorable to the production of the disease about the jaws or neck. In a subsequent paper Lord[1] reports a similar finding in tonsillar crypts (4 cases). He suggests that the infrequency of actinomycosis cases of the jaw, as compared to alveolar abscess, may be due to the mixed infection present, the rapid multiplication of the pyogenic organisms preventing the actinomycetes from taking root in the tissue. Shiota states that in two-thirds of his 34 cases of actinomycosis of the head and neck the teeth were more or less carious, and in 11 patients the first symptom was toothache. Jaehn[2] also reports the findings of numerous sulphur granules in decayed teeth and in the pus of perialveolar abscesses. On the other hand, Harbitz and Grondahl[3] obtained negative results invariably.

The last-mentioned writers bring up the important subject of the portal of entry, and state that the identity of the organism causing the disease in man has not been proved to be the same as that producing "lumpy jaw" in cattle. Furthermore, actinomycosis occurs in far separated localities, and is just as common in cities as in the country.

Clinical Aspects.—A few observations add a little to our knowledge of this aspect of actinomycosis. Opokin[4] reports 57 cases from Russia, and states that every case of chronic putrid bronchitis and pleuropneumonia with unusual phenomena should be investigated as a possible case of actinomycosis. Short,[5] in reporting 3 cases of actinomycosis of the appendix, states that the diagnosis may be made by the presence of a mass in the right iliac fossa with but little pain, tenderness, or fever, and the finding of the actinomycetes in the stools. The finding of massive adhesions at operation, and the later development of secondary abscesses and fistulæ, with involvement of the subphrenic space and base of the lung, should always lead to a search for the specific organism.

No mention was made of actinomycosis of the kidney in Vol. I. Garceau[6] states that in the reports of 128 autopsies, collected from various sources, in which there was actinomycosis of some organ, there was mention of undoubted actinomycosis in the kidney in 11 instances, or 8.6 per cent. It is extremely probable that the kidney is never the primary seat of the disease, nor can the trouble be recognized clinically unless the actinomycetes are found in the urine; the prognosis is very bad, and nephrectomy in the early stage offers the only hope.

Several French investigators[7] report that it is possible to differen-

[1] Jour. Amer. Med. Assoc., 1910, lv., 1261.
[2] Deut. Monatsschr. f. Zalnheilk., 1909, Heft 1 to 3.
[3] Amer. Jour. Med. Sci., 1911, cxlii., 386.
[4] Archiv. klin. Chir., 1908–09, lxxxviii., 460.
[5] Lancet, 1907, ii., 760.
[6] Tumors, etc., of the Kidney, 1909, D. Appleton & Co.
[7] Annals Institut Pasteur, 1910, xxiv., No. 1.

tiate actinomycosis by agglutination and the fixation of the complement test, using for the purpose spores of the sporotrichum. Harbitz and Grondahl have repeated these tests with negative results.

Treatment.—It would seem as though the cure of this disease depends, to a great extent, upon the area of the body involved and its accessibility to local treatment. When the thoracic or abdominal cavities are involved the mortality is frightful, and dependence seems to be placed almost entirely upon the internal use of potassium iodid. A thorough operation should be done, even though the primary mortality might be high, in order to open up the sinuses to disinfection and drainage. The exact action of potassium iodid is unknown, and there is some diversity of opinion as to the dosage required and as to its value. Wild[1] advocates very large doses, even up to 240 gr. daily, given every two hours during the day time (eight doses of 30 gr. in 4 to 6 ounces of milk). Maier prefers sodium iodid, and does not advocate large doses.

Harbitz and Grondahl doubt the curative action of potassium iodid, as they have shown that the fungus grows luxuriantly in 1 to 2 per cent. potassium iodid. Adair[2] is also skeptical as to the good accomplished by the use of potassium iodid. He points to the fact that internal actinomycosis is highly fatal despite of the drug, while the external forms may recover by reason of the free and uninterrupted discharge of the organism. He noted improvement from a 10 per cent. solution of formalin in glycerin, swabbed into the sinuses. Shiota likewise does not place much confidence in potassium idod. He excises the mass if it is small and circumscribed, or depends on incision and curetment and the injection of a 3 to 5 per cent. solution of silver nitrate into the mass.

Several cases of cutaneous actinomycosis have been described by British writers[3] in which the *x*-rays, together with potassium iodid internally, have given good results.

Finally, the methods of Wright have led to an attempt to treat actinomycosis by specific therapy. Wynn[4] had a successful result in a case of actinomycosis of the lung and liver. Whittier[5] also obtained good results, the opsonic index of his patient rising from 0.58 to 1.34. Frazier[6] reports a case of abdominal actinomycosis in which bacterial therapy was ineffectual. Harbitz and Grondahl treated 2 cases with 1 recovery; they describe the method for preparing the vaccine.

EMPHYSEMATOUS GANGRENE.

As was stated in Vol. I., p. 526, the clinical phenomena produced by the bacillus of malignant edema and Bacillus aërogenous capsulatus are identical. The recent writings refer entirely to the latter organism,

[1] Brit. Med. Jour., 1910, ii., 851.
[2] Northwestern Lancet, Sept., 1908.
[3] Lancet, 1909, ii., 468.
[4] Brit. Med. Jour., 1908, i., 554.
[5] Jour. Amer. Med. Assoc., 1909, lii., 1453.
[6] Annals of Surg., 1911, liv., 133.

the most complete of which are those by Blake and Lahey,[1] of Boston, and by Hewitt,[2] of St. Louis. Each author reports 10 cases, and in their discussion bring the subject to date.

Since Dr. Welch's first paper on the subject, with the exception of the discovery by Dunham in 1897 that the organism produces spores, little has been added to our knowledge of its bacteriology, its clinical aspects, or to the method of treatment.

Etiology.—The infection occurs most frequently from the contamination of street dirt, railroad dirt, elevator dirt, and intestinal tract discharges. Laborers and railroad men are, therefore, especially prone to infection. The incubation period is about forty-eight hours.

In a series of 36 cases of compound fractures or severe lacerated flesh wounds, Klotz and Holeman[3] demonstrated the presence of Bacillus welchii, or one of the members of this group, in the wound secretion. Clinically, they showed evidence of the same infection. Of the 36 cases, 20 were coal-miners who had received their wounds while at work in the mines, and the investigators had no difficulty in isolating Bacillus welchii from the soft earth traversed by the mules and in rooms polluted by dejecta.

Herter[4] has shown that in certain forms of disease the human intestinal tract contains an excessive number of bacilli belonging to this group.

Symptoms.—Hewitt distinguishes three principal types of the infection—simple, fulminating, and mixed. In the simple cases there is a slight rise of temperature and pulse, the patient appears quite ill, and a dark bloody, syrupy discharge with a few bubbles is noted. Pus is not present.

The fulminating type presents high fever, rapid pulse, rapid respiration, and the patient appears critically ill. The wound discharges a dark, thin, syrupy, foul-smelling material containing air-bubbles. On the extremities the appearance may suggest erysipelas, without the raised borders, and gangrene rapidly ensues with much gas formation, emphysema, and crepitus. Pain is rarely present, toxemia is pronounced in seventy-two hours, and later nausea, vomiting, and delirium indicate a generalized infection. The process extends chiefly by direct extension, as the gas separates and dissects between muscle and fascial planes and follows the lines of least resistance. The lymph-nodes are not involved unless other organisms are present, probably owing to the rapidity of progress. The tissues about the wound become soft, friable, and pulp-like, while further away the tissues are pale and edematous, until they in turn are converted into a pulpified state.

Mixed infections, whether streptococci or staphylococci, usually remain at the site of the inoculation and are mild in character.

[1] Jour. Amer. Med. Assoc., 1910, vol. liv., p. 1771.
[2] Ibid., 1911, vol. lvi., p. 959.
[3] Jour. Infect. Dis., 1911, vol. ix., p. 251.
[4] Jour. Biol. Chem., 1906, ii., p. 1.

Treatment.—The treatment is always operative. The wound should be opened by the removal of sutures and allowed to gape widely; it should be frequently sprayed with hydrogen peroxid or oxygen, carried into the depths of the wounds through a catheter. Ordinary antiseptics, such as tincture of iodin, bichlorid of mercury, etc., have little or no effect on the organism. Multiple incisions should be made in all boggy tissue in the very early cases. If the process is acute and rapidly extending, amputation must promptly be performed, and if not done before the third day of the disease is rarely successful in saving life. The amputation wound should be left open and frequently irrigated with hydrogen peroxid. Gilpatrick[1] advocates the use of a stream of oxygen, run into the incision under the dressings.

[1] Boston Med. and Surg. Jour., 1910, clxii., 744.

CHAPTER XCI.

DISEASES DIRECTLY DERIVED FROM ANIMALS, INSECTS, AND REPTILES.[1]

By Charles Harrison Frazier, M. D.,
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RABIES, OR HYDROPHOBIA.

In a recent paper Schroeder (Bureau of Animal Industry, Circular 120, U. S. Department of Agriculture[2]) remarks that "a deliberate denial of the existence of rabies means one of two things, either a lack of information or an impeachment of the honesty of innumerable impartial observers and investigators."

There is distinct evidence that rabies is increasing in frequency in the United States, particularly in the eastern portion, probably due, to some extent, to an increasing activity of state and municipal agencies in securing and examining material for diagnosis. During the year 1908 a survey of the situation by Kerr and Stimson[3] revealed 111 deaths in man during that year. Rabies was reported in the lower animals from at least 534 localities in 39 states and territories. In Great Britain the disease is now practically extinct, as the result of well-applied suppressive measures.

The disproportionate prevalence of rabies during certain seasons of the year, long a matter of popular belief, has but little foundation in fact. The total number of observations from different countries show that the disease is prevalent throughout the year without respect to season.

Etiology.—Rabies is generally considered to be caused by certain micro-organisms of a protozoan nature, commonly styled Negri bodies (see Vol. I., p. 533), but there is some division of opinion as to whether it is the parasites themselves that cause the disease, whether these contain a much smaller parasite in their interiors, or whether they represent a specific reaction of the nerve-cells to the poison. Negri[4] has recently described the developmental cycle of the organism, and classes it with the sporozoa. In the laboratory of the Bureau of Animal Industry their detection in the nerve-cells of the brain suffices for a diagnosis of rabies without animal inoculations.

[1] Supplementary to Chapter XIV., Vol. I., p. 530.
[2] Other Bulletins have been issued from this department, written by Hart and Mohler, and Stimson has compiled an excellent summary of rabies in a Bulletin from the Hygienic Laboratory of the Public Health and Marine Hospital Service.
[3] Jour. Amer. Med. Assoc., 1909, lxiii., p. 989.
[4] Zeit. f. Hyg., 1909, lxiii., 421.

Pathology.—In the previous descriptions of the pathology of rabies (Vol. I., p. 532) emphasis was laid upon the changes in the pneumogastric ganglia as being diagnostic of the disease. At the present time such changes—irregular distribution of the chromatophilic element, vacuolization, shrinkage of the cell, and displacement of the nucleus—are regarded as being of considerable diagnostic importance, although not conclusive.

Symptoms.—In reporting the incidence of human rabies in Egypt, Bain and Maloney[1] describe the symptoms observed in 17 patients who developed rabies while in the hospital. Pyrexia was the most frequent initial sign, but it was inconstant, and occasionally rose from obscure causes unrelated to rabies. Mental unrest was unreliable. Pain in the throat, with difficulty in swallowing, was the first indication in 3 cases, cardiac irregularity in 1, and difficulty in walking in another. Usually, fever with emotional disturbances was quickly followed by the classical laryngeal symptoms, and the disease rapidly developed so as to place the diagnosis beyond doubt. Faucial congestion was entirely unreliable; salivation was not an early sign, usually appearing on the eve of the second or in the course of the third day. Laryngopharyngeal symptoms with spasm soon developed, and became intensified until the onset of paralysis.

The fundus was examined in 4 cases and no changes found, but strabismus was observed four times, ptosis twice, and nystagmus and photophobia each once. Exaggerated deep reflexes, clonus, head retraction, and other evidences of spasticity occurred with hyperesthesia, the latter involved various areas of the trunk and limbs, especially the lower, and was followed later by complete flaccidity and paralysis with anesthesia.

The diagnosis rests upon the consideration of as many of the following factors as are available: (1) History of exposure; (2) the length of the period of incubation, two weeks to one year; (3) the clinical symptoms and course; (4) the termination, usually, but not invariably, fatal; (5) the postmortem findings, gross and microscopic, and (6) the inoculation test upon animals (Stimson).

The length of the period of incubation varies with many factors, being shorter in females, children, in severe wounds, and in those who are handicapped by various diseases; it depends also upon variations in virulence, and the shorter the period to be traversed by the infecting agent the shorter will be the period of latency, other factors being equal. Koch[2] reports 4 cases that died of intercurrent disease a little while after being bitten by rabid animals, and yet there brains were rabific, conveying the disease to rabbits.

Treatment.—There has as yet been discovered no cure for the fully developed disease, and the symptoms only can be treated as they arise; this has been previously discussed (Vol. I., p. 534). The prophylactic treatment of exposed persons is, however, of the utmost importance.

[1] Lancet, 1909, xi., 772. [2] Zeit. f. Hyg., 1909, lxiv., 2, H., 258.

Local Treatment.—"It has been experimentally proved that prompt and thorough cauterization of a bite entirely removes the danger of hydrophobia. As these wounds are apt to be lacerated, it is frequently impossible to be sure that a thorough cauterization has been done. Nevertheless, attempts should be made. The wound should be thoroughly washed and bleeding encouraged, after which fuming nitric acid should be freely applied. The next best application is a watery solution of iodin."[1]

Stimson also believes that nitric acid is the best cautery to use, as the actual cautery is rarely efficiently used. He also cautions against nervous excitement, fatigue, alcoholic excess, and exposure to wet and cold.

Prophylactic Treatment.—Persons who have been bitten by rabid animals, or those suspected of being rabid, or who have had open wounds or scratches contaminated with the saliva of such animals, should receive treatment for the production of immunity by the inoculation of rabies virus so modified as to render it innocuous. This should be done within one week from the time the bite is inflicted. There does not seem to be any marked departure from the method of attenuating the fixed virus by drying, as introduced by Pasteur. It is shipped as a glycerin emulsion, ready for injection, or pieces of the dried cords of rabbits are sent to be emulsified by the physician using them. The State health authorities should be communicated with by those desiring to administer the treatment. The Hygienic Laboratory, U. S. P. H. and M. H. S., begin with the use of cords dried for eight days, and the injections of more virulent material are spaced through the treatment and increased in number near its termination. The use of fresh fixed virus has been advocated by Fermi, Ferran, and Proescher,[2] but Cumming[3] strongly condemns the method.

The injections are made under the skin of the anterior abdominal wall. According to Stimson,[4] a visible local reaction is noted in one-half of the cases treated. This consists of elevated edematous, reddened areas, surrounding the needle punctures, varying much in severity and inconstant in appearance. They are attended with itching, pain, and tenderness in variable degree. After the disappearance of the cutaneous phenomena nodules are still palpable under the skin, and there is some enlargement of the associated lymphatic nodes. The reactions appear ten days after beginning treatment, and are probably due to the foreign protein of the rabbit's nervous tissue, and are expressive of hypersusceptibility established by the early injections. The treatment by these preventive inoculations is almost without danger. In the many thousands of inoculations there have been reported about 80 caxes of paralysis, with 4 deaths. But, as Stimson pertinently remarks, "these cases cannot be considered as seriously

[1] Ravenel and Hammer: Wisconsin Med. Jour., 1911, ix., 565.
[2] New York Med. Jour., 1909, xc., 688.
[3] Physician and Surgeon, 1910, xxxii., 225.
[4] Jour. Med. Res., 1910, vol. xviii., p. 511.

impairing the value of the treatment, any more than deaths from the administration of anesthetics, fat embolism in the reduction of fractures, etc.," can be considered to favor the general abandonment of these procedures. The condition usually appears during the latter part of the treatment, and manifests itself as a peripheral neuritis or as a myelitis. It is to be diagnosed from paralytic rabies by the slight initial fever, the reference of pain to the site of injection, and not to the bitten part, the short period of incubation, and the rapid termination by recovery. Koch believes that these paralyses are really cases of myelitis, due to the street virus and not to the fixed virus.

The value of the Pasteur treatment cannot be overestimated. There are many reports in the literature of the work of the various Pasteur institutes. Hart quotes the following interesting observation of J. N. Brawner, from the Pasteur Institute at Atlanta, Georgia: "Up to the present time they have treated 670 patients with only 2 deaths, one of these occurring in a victim of the morphin habit, the percentage of failures being only 0.33. Three other cases developed the disease during treatment. Dr. Brawner, during the past seven years, has also kept a careful record of all reported cases of persons bitten by rabid animals in Georgia who did not take the treatment, and of 120 such persons 29 died of the disease. This observation is of the greatest importance, and represents the signal value of the preventive inoculations which, in this one instance, showed a decrease in the mortality from 24 per cent. without treatment to 0.33 per cent. with treatment. The bites of rabid animals in Georgia, therefore, have proved seventy-two times as fatal without treatment as with it."

Prognosis.—It has been conceded that the average mortality of all persons bitten by rabid dogs is about 16 per cent.; in other words, one in six of persons so bitten develop the disease. Practically *all* who develop it die of it. The total figures of the Pasteur Insitute for the twenty years, from 1885 to 1905, were that 20,201 persons were treated. The mortality of the last three years was 0.32 per cent. Similar figures may be obtained from other Pasteur institutes, and illustrate eloquently the value of the treatment; the only question at issue is as to the best form in which to administer the virus.

"The treatment fails in cases in which the incubation period is too short to allow the necessary time for immunity to develop, in cases in which it is resorted to too late, and in those rare cases in which, from unexplained peculiarities of personal make-up, the individual is incapable of producing antibodies. These failures amount to less than 1 per cent."[1]

The suppression of rabies is easily attainable if laws covering the following points could be made and properly enforced. The features to be embodied in these laws are suggested by Schroeder as follows:

(1) The proper licensing of dogs and the extermination of those that are not licensed.

[1] Stimson, Jour. Amer. Med. Assoc., 1910, liv., 266.

(2) The proper muzzling of all dogs when they are in public places or on public highways.

(3) The holding of dog-owners responsible for the damages traceable to their dogs.

Acquired Immunity.—The use of a serum in the treatment of rabies has not received much attention except from a few investigators. The difficulty of deciding whether the virus of rabies is a toxin or due to a germ has militated against disturbing the present plan of treatment. This interesting subject is fully discussed by Stimson in his pamphlet. Semple[1] describes the preparation and use of an antirabic serum, and believes that it is indicated as an adjunct to the ordinary method of treatment in severely bitten and late cases, and in severely bitten cases, seen early it may be injected into the wounds and tissues in the vicinity.

One practical fact may be gleaned from these papers, and that is the necessity for inducing a leukocytosis as the first step in establishment of immunity.

SNAKE-BITE.

There is but little to add to the description given in Vol. I., p. 539. Wilson[2] has published excellent articles upon snake-poisoning in the United States. His paper is based on 740 cases of poisoning. He states that, technically speaking, it is correct to say that there are over twenty species of poisonous snakes found in the United States, but practically the number may be placed at four—the coral snake, the rattlesnake, the copperhead, and the southern water moccasin. These are all found together only in the group of states extending from mid-Texas to the Carolinas inclusive, the remainder of the country harboring, at the most, not more than two of the four mentioned. The presence of a pit between the eye and nostril, on the side of the face, or of the divided ventral scales on the tail, immediately stamp a snake as dangerous, and the absence of these points indicates the harmless character of any snake in the United States, with the single exception of the gaudily colored coral snakes, confined entirely to the Southern States.

The physical, chemical, and toxic properties of venom have been extensively studied, and serve to show that in venom we have one of the most complex poisons known. The colubrine venoms are characterized by the severity of their attack on the central nervous system, by their peculiar selective action on the respiratory center, and by the comparatively mild local manifestations at the site of their inoculation. The crotaline venoms (rattlesnakes) exert their toxic action by their ability to profoundly lower blood-pressure, probably because of their direct selective action on the vasomotor center; their disintegrating action on the endothelium of blood-vessels, resulting in the occurrence of multiple hemorrhages, and their antibactericidal effect on the blood-serum. They also inhibit coagulation, depress the function of the cord and medulla, and, in the case of the copperhead and water

[1] Lancet, 1908, i., p. 1611.
[2] Archiv. Int. Med., 1908, i., 516; Jour. Amer. Med. Assoc., 1910, lv., 771.

moccasin, exhibit a slight tendency toward a selective action on the respiratory center.

Prognosis.—Willson differs from previous writers in his mortality percentage. He places the coral snake first, with probably 25 to 50 per cent.; water moccasin, 17 per cent.; large species of rattlesnakes, 11 or 12 per cent.; copperheads and ground rattlers, nil in uncomplicated cases in adults up to about 5 per cent. of all cases.

Treatment.—The use of potassium permanganate has been condemned by several writers. Lyon[1] believes that the following line of treatment, if instituted within one-half hour, is very effective and reliable. Withdraw the fangs and apply a ligature, handkerchief, necktie, garter, suspender, or a few blades of grass, about 4 inches above the wound. Make a crucial incision, and promote free local hemorrhage. Administer strychnin, gr. $\frac{1}{40}$ or $\frac{1}{30}$, preferably the nitrate, and repeat at intervals, as demanded by the patient's condition. Inject 5 or 6 minims of a 10 per cent. freshly prepared solution of calcium chlorid into ten or twelve different areas within 2 inches of the wound. Regulate the pressure of the tourniquet by releasing it for a few seconds at intervals of fifteen minutes. Maintain absolute quiet.

Rogers[2] defends the use of potassium permanganate, and reports 21 cases with only 1 fatality. Madame Phisalix[3] has demonstrated the possibility of using an extract made from the skin of the salamander as an antidote to snake-poisoning. The substance is in the nature of an alkaloid, quite diffusible, and found experimentally to be distinctly antagonistic to snake-poison.

Scorpion Venom.—Todd[4] states that in certain portions of Egypt many deaths occur as the result of scorpion sting, in one place representing 1.6 per cent. of the total death-rate. The venom exerts its toxic action upon the nerve-center, but is not fixed by it; it does not affect the blood as does snake venom. Todd gives a method for the preparation of an antivenom which promises to be of practical use.

[1] The Military Surgeon, 1910, vol. xxvii., p. 383.
[2] Lancet, 1909, xi., 424.
[3] Semaine Med., Aug. 18, 1909.
[4] Jour. of Hyg., 1909, ix., 69.

CHAPTER XCII.

THE TRAUMATIC FEVERS.[1]

By Eugene Alfred Smith, M. D.,

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A reconsideration in general of the theoretic and clinical discussion of the traumatic fevers which is to be found in the chapter on that subject in Vol. I., p. 546, is not necessary to bring the subject abreast with our present knowledge. No writing or laboratory work has come to my observation bearing on the principles there laid down which would materially change the point of view. On the contrary, the voluminous writings on the huge amount of work done by patient workers in the study of immunity emphasize the point, made in that chapter, that the essential duty and desire of the clinician is to determine whether certain diseased conditions in his patient, which present the symptom-complex of one or all the forms of the traumatic fevers, are due to an infection or not; and, second, if an infection is the cause, what is the invading organism, and where is it located, or, if the infection is mixed or multiple, what are the invading organisms and where are they located?

This article will deal with the new work which has been done in the past few years tending to explain the cause of fevers, with some new work which is of interest to the diagnostician, and with a great field of new work which has been opened by Wright and the followers of his school in the treatment by vaccine therapy of diseases due to infections. It is claimed that prognosis has been materially improved by this treatment in many of the chronic diseases due to infections, and also in some few of the acute septicemic diseases due to general infections.

Fever.—Studies of anaphylaxis point strongly to protein substances present in the blood as the causative element in all fevers. Some are aseptic, being of vegetable or animal protein origin, and some are septic, in the sense that they are due to parasites, bacterial, or protozoan in nature. Hay-fever is thus explained as a systemic reaction to the absorption of vegetable protein by a susceptible respiratory mucous membrane. Aseptic traumatic fever is also explained as due to protein absorption from effused blood after surgically clean operations, and injuries followed by subcutaneous or deep hemorrhages or exudation, but in which no infection occurs. Septicemia and pyemia, in their turn, are said to be due to cleavage products produced by the

[1] Supplementary to Chapter XV., Vol. I., p. 546.

action of blood and tissue ferments on bacterial proteins in the patient's blood. Hay-fever and other anaphylactic manifestations of the same kind, and aseptic traumatic fevers, plainly belong to the toxemias, following the classification given in Vol. I., while the fevers following all infections just as plainly belong to the septicemias.

The result of these studies of anaphylaxis, so far as clinical surgery is concerned, points to the reasonable certainty of fever of simple protein or aseptic type following closed contused wounds, clean incised wounds, the wounds of aseptic operations, sprains and simple fractures. On the other hand, all fevers following open, lacerated, and gunshot wounds, burns and scalds, compound fractures, the wounds of operations in infected tissues, and also the wounds of operations with faulty technic of asepsis or antisepsis, are more likely to be due to proteins of parasitic organisms, and, therefore, septic in nature.

Terminology.—Naturally in the past few years some new terms have come into use, while some old terms have somewhat changed their meaning. Some writers already use the name protein fever in speaking of fever, whether aseptic or septic in origin and progress. They would probably recommend the surgical protein fevers as the proper heading for this chapter in place of the traumatic fevers. I might offer, as an additional argument for such a change in nomenclature, the fact that many septic fevers are not actually traumatic in origin, but are only theoretically so, in the sense that they are due to an invasion of a pathogenic parasite through or at a spot of lessened resistance of the body fluids or tissues.

An increasing number of medical men are dropping the words sepsis and the synonym septicemia, although there appears no good reason for such action. They use the word infection to cover not only the invasion of a pathogenic organism, but also to include the clinical symptoms of the septicemia which are due to it. The word infection is qualified by the name of the organism when known, as, for instance, a streptococcic infection.

Some writers wish to limit the meaning of septicemia by making a bacteremia one of its necessary features. This is an unnecessary limitation. It is well known that few infections are followed by bacteremia, excepting in the terminal stages, and, therefore, the invading organism can only occasionally be determined by culture from the blood in the early days of most septicemias at the time when diagnosis is most important. Bubonic plague is always a septicemia, but, in the purely bubonic type, it is not a bacteremia, and probably only becomes a bacteremia when the glandular barriers are overcome.

Some other debatable points might be mentioned, but it seems better to refer the reader back to the original chapter for a full theoretic and argumentative discussion of the problems arising from inaccuracy and confusion on the part of medical writers in the nomenclature of the traumatic fevers.

Diagnosis.—In the general study of diagnosis much work has been done to aid the clinician in many diseases in which septicemia plays

a part. This work is to be found in hundreds of articles which have appeared in medical journals in the past few years, and it has been summarized in the most recent works by authors in the various specialties of medicine. Much of the work is in the nature of refinements of clinical observation, based on large, limited, or unique experiences on the part of the writers.

But some new laboratory tests have been developed in the study of immunity, and some old tests have been modified, which the surgeon now makes use of to aid him in diagnostic work in the special study of the traumatic fevers. These tests are to be sought for under the proper chapters in this volume, and will be merely enumerated in this article in discussing the differential diagnosis between the aseptic and septic forms of fever.

Differential diagnosis between these forms of fever is not so difficult when they follow that class of traumatisms already mentioned as most liable to be followed by infections, but when they follow the class of traumatisms mentioned as not so liable to infection the difficulty is greater. After operations on the body cavities, where the field of work is quite hidden upon closure of the wound, diagnosis of a beginning sepsis may be extremely difficult. This is especially so with the sudden or insidious onset of fever some hours or days before localizing symptoms of an infection develop. When, for instance, a previous pelvic or other intra-abdominal disease has existed, it may be difficult to exclude an atypic typhoid fever in cases of local or beginning general peritonitis. The obscurity of diagnosis in such cases is made more hazardous for the patient and trying for the surgeon because a possible perforative visceral lesion may be present. At times diagnosis is so difficult that an exploratory operation becomes justifiable and necessary to determine the cause of the disease, with the hope of removing the cause if it is possible.

Many examples of uncertainty and difficulty will occur to every clinician where the one plus one, which make two in the *science* of medicine, total far more or much less in the *art* of medicine so far as diagnosis is concerned. The man who in his practice of the art of medicine can make use of all the factors afforded him by the scientific study of his cases, and can then best apply the element of probability in arriving at his conclusion in doubtful cases, is the man who makes diagnoses with reasonable certainty, and of whom medical men say that he has the so-called clinical sense.

In doubtful cases of differential diagnosis between aseptic and septic forms of fever, diagnosis may be determined with reasonable certainty by a painstaking study of the clinical course of the disease as recorded in the patient's history, by a careful physical examination of the patient, and a wise use of laboratory methods.

Widal's reaction may be of positive value, and, if not found, at least will be of negative importance in some obscure forms of peritonitis.

Blood-pressure is not raised in tuberculous peritonitis or in peritonitis due to malignant disease. It is raised early and sharply in the other

peritonitides. The clinician who watches his typhoid patient's blood-pressure is sure to give his patient a far better surgical chance in the early hours of a peritonitis due to the perforation of a typhoid ulcer, in the event of that catastrophe occurring.

Wassermann's test for syphilis, devised in 1906 and modified by Noguchi in 1909, should be applied in the study of many low-grade septicemias, and the same may be said of von Pirquet's test and the tuberculin test. Inoculation of guinea-pigs with suspicious granulations or exudate often proves of positive value in the diagnosis of obscure tuberculous processes.

Microscopic study after proper staining and culturing on proper media of the sputum, of the fluid from a lumbar puncture, and of all the discharges from wounds or aspirated fluid from natural or unnatural cavities, may yield the diagnosis of the invading organism in a septicemia. In the absence of positive findings a septic process is not always positively excluded, but sometimes it is, and in many cases it may be said that the absence of findings points more or less strongly to the aseptic form of fever.

Many septicemic cases call for chemical and microscopic examination of the stomach-contents and the feces. Routine examination of the urine for specific gravity, albumin, and sugar is necessary in all surgical cases, but, in addition, certain cases call for special microscopic urinary examination, and in suspected tuberculosis of the genito-urinary tract a culture or guinea-pig inoculation test may be the means of settling the diagnosis.

Blood examinations, including the percentage of hemoglobin and differential leukocyte counts, are of positive, and, at times, of convincing value to the surgeon in the diagnosis of septicemia. They settle the question of the invading parasite in malaria, and establish the diagnosis in a number of the diseases which the surgeon is glad to exclude, but which are of more interest to the internist, such as leukemia and pernicious anemia.

A normal white leukocyte count or a leukopenia may be present in a septicemia due to pyogenic infections, but it is exceptional, and usually explained by a failing resistance on the part of the patient in virulent infections, or by an infection not virulent in type. Leukopenia points to a typhoid infection in an acute septicemia with atypic clinical symptoms when a positive Widal test is present, and so it does also in a case clinically more typic of typhoid with a negative Widal reaction. With a low-grade septicemia, a positive von Pirquet test, and some symptoms of a chronic local or general peritonitis, a leukopenia points strongly to a tuberculous infection of the peritoneum.

Leukocytosis and iodophilia are now quite generally recognized as valuable aids in the diagnosis of sepsis, but, it seems to me, there is no good ground to change the general conclusions already given on this subject in the original chapter on Traumatic Fevers in Vol. I.

In some obscure infections diagnosis can be made by the study of the patient's opsonic index, testing out several of the infecting

organisms likely to be the cause of his septicemia. Of all the laboratory tests this is the most difficult in technic.

In general, it must be admitted that laboratory tests are beyond the skill of the average general practitioner, especially in country practice, with the possible exception of the ordinary red and white blood-cell counting. To be reliable, laboratory tests must be made by men specially trained in clinical pathology. In cities and towns of large size they are usually made by such trained men for the specialists in surgery and internal medicine as well as for the men in general practice. This is one reason why patients suffering from obscure diseases are sent by conscientious home physicians from the country and smaller towns to large city hospitals and noted clinics for diagnosis and treatment.

Treatment.—Since 1906 Sir Almroth E. Wright, of London, has been the leader of the school of vaccine therapy. Wright aims to produce active immunity to infections by increasing the body's resistance to pathogenic organisms. He inoculates the patient with bacterial vaccines; that is, with killed bacteria of the same kind that are the cause of the patient's infection, the dosage ranging from a small number up to many millions, according to the case. He demonstrates that the opsonins of the blood are thus increased, the opsonins being the substances which unite with bacteria to prepare them for phagocytosis, and without which the leukocyte attack on bacteria does not occur.

The advocates of this line of treatment for diseases due to infection were, and indeed are, enthusiastic in their claims for the curative power of the method. Skeptics are not lacking, but criticism of the subject of vaccine therapy is directed less at the results of actual vaccine treatment in properly selected cases, and more at the uncertainty and unreliability of the method of determining the opsonic index.

This index is obtained by a mathematical calculation, following a technic devised by Wright. In healthy individuals it is called one, and it is expressed in fractions of one or as one plus a fraction, in patients according to the quantity of opsonins in the patient's blood, as compared with the blood of one or more healthy persons. In other words, the opsonic index is the measure of the power of exciting phagocytosis possessed by a patient's blood-serum. Wright and his pupils admit that the estimation of the opsonic index is a difficult and exacting laboratory process, and that differing indices may be obtained in a given case when determined by different observers. But they claim that this laboratory method is the only proper way to study the variations in the index during the course of an infection, and the relation of the dosage of vaccines to the resulting negative and positive phases in the patient.

In chronic infections the negative phase, or period of lessened resistance, may be absent, short, moderate, or severe after vaccine treatment, and the dosage aims to increase this negative phase moderately, with the expectation of an increased opsonic index in the positive phase. The negative phase when moderate is clinically shown by some local

reaction about the site of the infection, and possibly by a rise in temperature, with some depression and general discomfort. The positive phase follows and the patient reacts, feels better, and more or less local change in the line of improvement is to be expected, and in time may be noted as treatments continue.

In acute septicemias, and especially in the bacteremic forms, the negative phase is apt to be severe and prolonged and vaccines are always dangerous. If helpful at all, they are only so in small and guarded doses, controlled by men experienced in vaccine therapy and able to govern the dosage by careful study of the variation in the patient's opsonic index before and after treatments. A prolonged negative phase, with little or no positive reaction, is to be feared, because such patients are getting full stimulation of their opsonin production by auto-inoculation to the point of failure in resisting power.

Dosage, based solely on the clinical study of the effects of vaccines, is only safe in distinctly localized staphylococcus, gonococcus, tubercle bacillus, and possibly a few streptococcus infections, such as acne, furunculosis, carbuncle, cellulitis, gonorrheal arthritis, and tuberculous sinus, skin, gland, joint, bone, and genito-urinary infections.

When pulmonary tuberculosis is present tubercle bacillus vaccines are dangerous, and must not be used in the treatment of local tuberculous lesions. Lawrason Brown, of Saranac Lake, reports 4 out of 8 cases of pulmonary tuberculosis which showed improvement following vaccine inoculations with autogenous vaccines prepared from the secondary organisms, streptococci and pneumococci, which were obtained by culture from the sputum of the patients.

It is likely that dosage will be controlled by clinical results, fortified by simpler methods of obtaining the opsonic index in the future. It is also likely that simpler and more certain methods of diagnosis of the infecting organism in diseases due to infection will be found, and vaccine therapeutists expect great improvement in results when vaccine treatment is uniformly conducted with autogenous vaccines.

Many practitioners now use stock vaccines made by large drug firms. They do not control their dosage by determination of the opsonic index, depending entirely on the clinical symptoms in trying for results. Their diagnoses are often wrong, because they do not make bacteriologic studies to determine the infecting organism in their patients. Reports of cases and statistics made by such observers are valueless. But the work of Wright and many other competent men prove that vaccine therapy is of great value in the treatment of diseases due to infections, especially chronic infections.

Vaccine therapy will not displace operative and orthopedic surgery. All infections, especially those in deep tissues and body cavities, which can be attacked or removed as a local cause likely to produce a more dangerous local sepsis or a more serious general sepsis, must be treated by operation. It would be folly to treat an infected appendix or gall-bladder by colon bacillus or other vaccines. Here a perforative lesion

is always possible, and the infecting organism may not be single, but the infection may be mixed from the onset or have become multiple later. If we grant that chronic mastoid disease of pneumococcic origin and local bone diseases of tuberculous origin have been cured by appropriate vaccine inoculations, we may also assert that acute mastoid disease and other bone infections, due to pyogenic organisms, simple, mixed, or multiple in type, need operative surgery.

Pyemia.—In pyemia the guarded use of appropriate vaccines may be beneficial, especially in the chronic cases, with accessible metastatic abscesses, which can be surgically reached and evacuated. In cases with inaccessible foci of infection and those with multiple metastatic abscesses, in which frequently the invading organism can be cultured from the blood, the use of vaccines is dangerous and contraindicated.

Prophylaxis.—Success has been obtained in the prophylaxis of typhoid fever by inoculations with typhoid vaccines. Some prophylactic work has been done to protect patients exposed to infection by vaccine inoculations with several bacteria, especially the common strains of pyogenic organisms. Beyond doubt, as time develops our knowledge in this line of work, vaccine prophylaxis will become a much more important matter in the class of traumatisms already mentioned as most liable to infection.

In diphtheria and tetanus and one or two more diseases, such as cerebrospinal meningitis, the surgeon and internist resort to serum therapy to obtain passive immunity in exposed and infected individuals, and in diphtheria especially, with remarkably excellent results. Reasoning broadly, and from a practical and clinical experience already large, much greater beneficial results in prophylaxis and treatment may be expected in the wider field of active immunity by the development of vaccine therapy in the prophylaxis and active treatment of the many other diseases due to infection.

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CHAPTER XCIII.

SURGICAL TUBERCULOSIS.*

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Treatment With Tuberculin.—The attitude of the profession as a whole at the present time is distinctly unfavorable to the use of tuberculin in the treatment of tuberculosis. The early disastrous results, following its introduction by Koch, soon led to its practical abandonment. Koch, followed by other authorities in Germany, and by Trudeau in this country, continued to use it, improving the effectiveness of the tuberculin and its method of administration. Although at the present time the physicians and surgeons employing it are relatively very few in number, its supporters are undoubtedly increasing. In this country it has found its strongest and most continuous support among those physicians who are particularly interested in the sanatorium treatment of phthisis. They have been using it for years, and report results which, while not brilliant, seem to be positively beneficial. Trudeau[1] says that tuberculin has, within certain limits, a favorable influence on the course of the disease, and that the results of sanatorium treatment could be improved and made more permanent by its application. It is, however, looked upon not so much as a specific, as an aid to the hygienic and dietetic treatment, and the tendency while using it is to depend much upon general hygienic conditions and fresh air, while the tendency toward overfeeding is less marked than formerly.

Tuberculin has not been employed as extensively in the treatment of surgical tuberculosis as in that of phthisis, many surgeons taking a decided stand against it. Ridlon[2] considered that tuberculin administered by the clinical method in harmless doses was useless, and that in larger doses it was both harmful and dangerous. Painter,[3] in a recent paper on vaccine therapy in arthritis, says that the results of experimental studies, though contradictory in many respects, are perhaps no more so than should be expected in the earlier researches into so complicated a subject, and are certainly strikingly instructive in many of their findings. As regards gonorrheal and tuberculous joint affections, there does not seem as yet to be any well-established theoretic grounds for the belief that vaccination after infection could play a curative rôle. Practically, there is very little evidence that it ever has. There is abundant reason for thinking that the future treatment of

* Supplementary to Chapter XVIII., Vol. I., p. 593.

these conditions (gonorrheal, tuberculous, chronic non-purulent and syphilitic arthritis) will be much more facilitated by vaccine therapy than they are now. There is very little reason for thinking that they are at present even adjuvants to our therapeutic measures, with the possible exception of Marmorek's serum in the treatment of tuberculous arthritis. Painter, however, has not employed the vaccine method, but says that Wright's method, guided by the clinical rather than by the laboratory findings, should be used if a vaccine is to be employed in treating osseous lesions.

On the other hand, Hawkes and Floyd[4] present a much more favorable view of the value of tuberculin as a vaccine. They treated, during a period of four years, 143 dispensary patients suffering from various forms of tuberculosis. Of these 19 died, 16 showed improvement, while 108 benefited to a greater or less degree. In no case was tuberculin observed to have done the slightest harm. They found that it will do the most good in incipient phthisis and in surgical tuberculosis, whether of bones, glands, joints, or other tissues, but they insist that there should be a close co-operation between the patient and the physician. The tuberculin was regarded as only one factor in the treatment, in many cases being distinctly subordinate to an open-air, hygienic life; in others, especially where the general condition of the patient was excellent and the disease a purely local process, tuberculin was the important factor in bringing about any improvement which took place. The results of Hawkes and Floyd tend to show that tuberculin can be used to advantage without the aid of climate or a strict sanatorium treatment. Raw, of Liverpool, basing his conclusions upon 1600 cases of surgical tuberculosis, says that his results have been successful beyond his anticipations. In certain German clinics, notably that of Hammer at Heidelberg, tuberculin is employed in every case. Hartwell and Streeter[5] do not advocate tuberculin in preference to operation for tuberculous glands. They believe that a radical excision is the procedure of choice in the majority of cases, on account of the great saving of time and the immediate removal of infected tissue, which may be a possible menace. Tuberculin may be resorted to when operation is contraindicated or refused, and they suggest its employment as an adjuvant to operation. They would use it to prevent recurrences after operation. In extensive involvement of cervical glands they would remove the most prominent, leaving the smaller nodes to be taken care of by the tuberculin. It may also be employed to take away periglandular infiltration, so that the hard and freely movable glands can be shelled out through an open incision. Murphy[6] has not made a typic cervical adenitis operation in over six years. All except the suppurating nodes are cured by tuberculin. From the foregoing it would appear that tuberculin had justified the efforts of those who had brought it to its present stage of development, and that it deserves a more extensive trial than has been given to it up to the present time.

Since Koch[7] introduced it, in the form known as Koch's old tuberculin (T.O.), many varieties have been employed, but they do not

differ essentially from each other. The skill of the physician using the tuberculin is regarded as more important than the particular brand employed. Koch's new tuberculin (T.R.) is being most extensively used at the present time. While Wright's researches on the opsonic index have led to much greater use of tuberculin, there is much doubt as to the value of the opsonic index in the guidance of the dosage, and there is a pronounced tendency just now to depend rather upon the clinical condition of the patient. If the opsonic index should become the established method of estimating the amounts of and the periods at which the tuberculin is to be given, many patients cannot receive its benefit because of the exact and time-consuming laboratory technic involved. A distinction, however, must be made between the value of the opsonic index and that of vaccine therapy.

Administration.—In order that infection and variability in dosage may be avoided as far as possible, it will be best to have the tuberculin prepared by a reliable firm, in glass capsules containing the amount necessary for one dose. It will also be best to keep the patient under observation in bed for several days before and after the injection of tuberculin. According to Wright, it should be given at first in doses of not more than $\frac{1}{1000}$ mg. of Koch's new tuberculin (T. R.), and doses of more than $\frac{1}{600}$ mg. should not be given. If the opsonic index is employed as the guide, the first effect of the tuberculin will be to lower the index (negative phase). This fall is followed by a rise (positive phase), and in a variable period the index returns, more or less, to its old level. The positive phase is characterized by an increased antibacterial power of the blood, and may be accompanied by a pronounced feeling of well-being. The object aimed at is to maintain the opsonic index at as high a level as possible, and, therefore, an accumulation of the negative phases or a too prolonged negative phase must be avoided. As a rule, inoculations are made about every tenth or fourteenth day. As already stated, the patient should be put to bed a few days before, and kept there a few days after, the injection, until it is known that he is not reacting unfavorably. The clinical method of observing the effect of the tuberculin consists essentially in watching the temperature and general condition carefully, and in not repeating the injection, or in repeating it in smaller doses, if reaction of any kind follows. To obtain good results the treatment must be kept up for several months.

Trudeau's rules[8] for the safe administration of tuberculin are as follows: Begin treatment with very minute doses. Raise the degree of tolerance to the highest attainable point by a long progression of dosage. Avoid general and local reaction as much as possible, regarding them merely as evidence of intolerance. Follow no arbitrary rules as to the rate of increase or the maximum dose to be reached, but be guided by the toxin tolerance in the individual case.

Tuberculin is contraindicated by persistent pyrexia (above 99.5° F.), by persistent rapidity of the pulse (over 100), by rapid wasting, by miliary tuberculosis or tuberculous meningitis, and by hemoptysis. Nephritis and epilepsy are further contraindications.

Iodoform-glycerin Emulsion with Bier's Hyperemia.—Kausch[9] has been employing this treatment in tuberculous abscesses, and reports gratifying results. The iodoform-glycerin should be injected under pressure in sufficient quantity and should be held in for five minutes, better ten, when if any fluid escapes it will be pure glycerin, the iodoform having settled on the walls of the abscess.

Injection of Bismuth-vaselin Paste in the Treatment of Cold Abscesses and Sinuses.—(See Freeman, Vol. VI., p. 41.)

Murphy's Formalin-glycerin Solution.—In the discussion of Meyer's paper on pneumectomy with the aid of differential pressure, read before the Surgical Section of the American Medical Association in 1909, Murphy suggested the injection into the pleural cavity for empyema, including the tuberculous variety, of a few ounces of a 2 per cent. solution of formalin in glycerin, provided the empyema did not communicate with a bronchus nor with the external body surface by a sinus.

Poley[10] says that for only four or five years has formalin been used to any extent in joint affections with effusion, and almost exclusively in Murphy's hands. Poley treated 16 joint cases by this method in Murphy's service. So far no literature on the subject has appeared, Murphy's first paper now being in preparation.

Indications.—The greatest percentage of cures has been obtained in acute and subacute joint inflammations, many of which are cured rapidly. Five to ten days previous to the time when one of the larger joints is to be opened, as for removal of a semilunar cartilage or inspection of the joint, it is injected for the purpose of stimulating the tissues to healthier resistance against infection. Primary tuberculous synovitis gives the best results under this treatment. Five minims of dilution No. 2 of Koch's old tuberculin are given subcutaneously to aid the history and radiograph in the diagnosis.

Preparation of Solution.—To each ounce of glycerin add 10 drops of formalin. Put into a sterile, glass-stoppered bottle and shake well. Sterilize in a steam sterilizer under pressure. *Never* use a solution less than twenty-four hours old, as it requires twenty-four hours for the formalin to dissolve in the glycerin. Two to twenty c.c. of this solution may be injected into the joint, depending on the size of the joint and the quantity and degree of dilatation of the capsule at the time of injection.

Preparation of the Patient.—If the knee is to be treated, the whole thigh and leg are shaved, scrubbed with soap and water, and a sterile pad is bound to the joint the previous evening. Before the operation the extension apparatus is applied, so that the weight may be swung immediately after the injection. The railroad splint consists of a double inclined plane and Buck's extension. The height is adjustable, from the horizontal to a right angle, by a thumb-screw at the lower end. The short and long arms of the incline are united by the strap hinges and thumb-screw to the sliding board, which moves with the patient up or down in the bed. The triangular portion of the apparatus " railroads," so to speak, on rollers between quarter rounds on the underlying base board, which should be prevented from sagging with the mattress by a cross board underneath it, resting on the side rails of the bed. From twenty to thirty pounds weight, enough to

overcome spasm and secure extension, are employed. Ten-inch blocks under the foot-posts not only secure additional extension, but prevent the apparatus lodging against the foot of the bed. Adhesive straps for extension are applied to the sides of the leg, up to the level of the tuberosity of the tibia, care being observed to protect the external popliteal nerve from pressure. The heel and popliteal space are well cushioned by cotton pads, another of which, between the foot and end plate, overcomes the tendency to drop-foot.

Articles Necessary for an Injection.—Tincture of iodin. Ordinary aspirating syringe and a graduated formalin and glycerin syringe, both of which fit the aspirating needle. Sharp-pointed scalpel. Ethyl chlorid for local anesthesia (nitrous oxid or ether anesthesia is much preferable to local anesthesia, on account of the intense pain following the injection and the not infrequent difficulty in entering the joint, *e. g.*, the shoulder). Sterile graduate for the aspirated fluid. Solution for injection (do not carbolize the aspirating needle). Cotton and collodion. Culture material.

Technic of Injecting the Knee-joint.—The joint having been painted with two coats of tincture of iodin, and the patient anesthetized, the aspirating needle is pushed into the joint, just beneath the outer edge of the patella. Free motion of the needle indicates that the cavity has been entered. The fluid is aspirated and the needle clamped by an assistant with an artery forceps. The aspirating syringe is taken off and the injecting syringe screwed on, and about ½ ounce of the solution slowly injected, the joint being completely filled. Equal distribution of the solution to every part of the joint cavity should be secured by flexion, extension, and massage. A cotton-collodion dressing is applied, the weight swung into place, and the patient given ¼ gr. of morphin immediately. A second morphin injection may be necessary in four to six hours, but after this the patient is very comfortable, and will not allow the weight to be removed.

On the second day there is a diffuse hyperemia, the skin assuming a delicate pink hue. An ice-bag may be applied for two or three days if necessary. On the fourth or fifth day the swelling begins to subside, and the pain becomes less severe on passive motion. The weight can now be removed daily, the joint massaged, and passive motion instigated. The interim between the injections is usually ten to fourteen days, according to the degree of swelling, pain on passive motion, and inflammation. Two injections are often sufficient, but as many as five are warrantable before giving up any case.

After the last injection a tuberculous case is allowed to walk on crutches four to six months. He should wear a long, three-fifths circular cast, and should receive tuberculin injections of 5 to 6 mg. once a week for the same period of time. The application of the *x*-rays are advised daily during the course of the formalin injections. Of Poley's 16 cases, 8 had tuberculous synovitis, and of these all except 1 was cured—5 after two injections and 2 after three injections. One case was improved after five injections, but this case had tuberculous caries of the ribs with external fistula.

Puncture of Tuberculous Abscesses.—According to Young,[11] the puncture of tuberculous abscesses for diagnostic verification as a routine procedure has been neglected. By it one can ascertain to a certainty the bacteriologic composition of the contents, the necessity for incision and drainage, or the opposite can be definitely determined. More important than the determination of the physical character of the fluid, the color, coagulability, odor, and transparency, is the information obtained by the microscopic examination and the culture findings. The examination should also include the cell counting, of the same character as for the cytodiagnosis employed in pleural effusion. The presence or absence of bacteria in large quantity, such as tubercle bacilli, staphylococci, streptococci, and actinomyces, can be readily determined by this microscopic examination. If the smear slides are not satisfactory, and the culture findings are negative for tuberculosis, inoculations of guinea-pigs should be made in suitable cases. The examination of the fluid taken from 25 operative cases several days before operation, all of which were diseases of the joint, showed 6 to contain tubercle bacilli, 6 pyogenic organisms, and 12 to be sterile. Among the organisms found were streptococci, staphylococci, bacillus pyocyaneus, and pneumococci. Of the cases with sterile abscesses (according to the microscopic examination and culture findings), inoculation of the pus into guinea-pigs showed that in 2 it was negative and in 1 positive for tuberculosis. The examination of the fluid enables the operator to determine whether an operation is immediately required, as well as the character of the operation demanded.

Traumatic Tuberculosis.—Weber[12] presents an interesting study of traumatic tuberculosis, as well as of traumatic pneumonia and traumatic pleurisy. Clinically, he divides the cases of traumatic tuberculosis into those due to direct inoculation by cuts, etc., and those due to injuries by which the tubercle bacilli could not have been introduced from without. Of those due to direct inoculation the examples are nearly all superficial, and include tuberculous warts (lupus verrucosus), "necropsy tubercles," and such other forms as are acquired by pathologists and their assistants from autopsies, and by butchers, etc., from tuberculous cattle. These are not, however, what are meant by cases of traumatic tuberculosis, and are not further considered by Weber.

Alleged traumatic tuberculosis, due to injuries by which tubercle bacilli could not have been introduced from without, are divided clinically into: (*a*) Cases in which a decided traumatism of some kind is followed by signs of either acute disseminated miliary tuberculosis or acute metastatic localized tuberculosis; (*b*) cases in which signs of pulmonary tuberculosis follow (or are first noticed) after a supposed injury to the lungs or the wall of the chest; and (*c*) cases in which an injury to bones or joints, or parts of the body other than the lungs, is followed by signs of tuberculosis more or less localized to the region of the trauma. The first group includes cases, fortunately rather rare, which

run an acute and often " dramatic course." A person (usually young), apparently in blooming health, may receive a chance blow or contusion of some kind, and die in four or five weeks of acute miliary tuberculosis. Weber relates several striking cases, showing that acute miliary tuberculosis may follow contusions, sprains, or surgical operations.

A number of interesting examples are also reported, showing that an injury to the thorax may be followed after an interval by active signs of pulmonary tuberculosis.

Traumatic tuberculosis has been chiefly discussed with reference to tuberculosis of the bones and joints. Many experiments upon animals have been carried out, to ascertain whether the localization of the manifestations of artificially produced general septic conditions can be determined by local traumata (without local inoculation). The results of such experiments were, to a great extent, affirmative, and have thrown much light on the pathogeny of diseases like acute infective or septic osteomyelitis. Similar experiments have been carried out with regard to the pathogeny of tuberculous disease of the bones and joints. Weber concludes that so-called traumatic cases in man must be explained, as the rendering manifest and active of a pre-existing tuberculosis, however limited in extent, quiescent, and latent such pre-existing tuberculosis may have been. An already manifest but chronic tuberculous process can be rendered acute as the result of traumatism. Such a transformation may occur within a few days or weeks after an injury, and a very rapid development of signs of acute local tuberculosis should always give rise to a suspicion that a clinically obvious (though chronic and possibly quiescent) tuberculous affection was present before the injury was received. Tuberculous lesions connected with local traumatism (contusions, etc.) may doubtless occasionally occur also in other parts of the body.

As to what part the traumatism plays in particular cases of alleged traumatic tuberculosis, of special importance is the knowledge that an outburst of traumatic tuberculosis (apart from that due to actual inoculation) is, pathologically speaking, according to the experimental and clinical evidence, the result of the disturbance of a pre-existing, though generally unrecognized and often quiescent, tuberculous process. It is, therefore, quite conceivable that a man might have an encapsulated caseous tuberculous nodule, not at the site of the injury, but at some distance from it—for instance, on the opposite side of the thorax—and that the injury may yet be sufficient to rupture it, so that the tuberculous disease may first show itself at some distance from the site of the injury.

Treatment With the X-Rays.—Iselin,[13] having previously obtained excellent results from the use of the *x*-rays in the treatment of tuberculosis of glands and other soft tissues, for the past two years has been employing the same treatment for tuberculosis of the bones and joints. In all, 41 cases were so treated, including those involving the bones and joints of the hand, foot, elbow, knee, sacro-iliac joints, and the ribs. The following method was employed: In the beginning of the

treatment the bone or joint was exposed to the *x*-rays three or four times at short intervals, every exposure being made from a different side and always with the fullest dose that the skin would stand, until all parts had been exposed. The rays were passed through an aluminum plate 1 mm. thick. Because the effects on the skin did not show until two or three weeks after the exposure, the same portion of the skin was exposed only once every three or four weeks, not more than three complete exposures being necessary. From the beginning the joints were placed in a position favorable for cicatricial contraction, except in the case of the small joints. If healing was obtained by cicatricial contraction, which occurred in 10 cases of bone and joint tuberculosis, after-treatment was necessary to reproduce the mobility of the joint involved. This consisted in "baking," massage, and movements of the joints. Almost always the progress was visible, and was obtained in many otherwise hopeless cases. The method was not suited to children, because the epiphyseal cartilages can be damaged by the *x*-rays, while in the large shoulder- and hip-joints of adults they could not be made to penetrate deep enough.

Wilms[14] reports a case of laryngeal tuberculosis treated by the *x*-rays, which, he says, confirms the effectual action of the deep Röntgen exposures in the treatment of this condition, as he has already demonstrated for tuberculosis of bones and joints. During the last year and a half he has found this treatment all that was necessary for tuberculous disease of the fingers, hand, elbow, foot, and ankle in adults, enabling him to dispense entirely with curetting and resections. Tuberculosis of tendon sheaths in the elderly reacts promptly to the deep exposures. No injury of the skin from the *x*-rays has been observed in 100 exposures. The deep action is obtained by the interposition of aluminum. Like Iselin, he does not use the method in children because of the possibility of injury to the epiphyses. In the case of laryngeal tuberculosis reported the lesion healed completely after two sittings.

Spontaneous Fracture of the Femur in Tuberculous Coxitis.—Eringhaus[15] says that to the symptoms usually accompanying tuberculous disease, especially of the large joints, belong trophic disturbances of the entire extremity involved. He has seen a series of not less than 6 cases, in each of which there was a fracture of the shaft of the femur just above the condyles. In the region of the lower epiphysis the *x*-rays show a high-grade atrophy of the bone. This is shown very clearly by the lessened depth of the shadow, the decrease of compact bone, and extensive changes in the spongiosa. The fracture occurs in this area. Eringhaus advises reduction of the deformity under narcosis and the application of a plaster cast in extension. In all of his 6 cases the fractured bones were completely consolidated in at least six weeks, with later complete return of function in the limb.

Tuberculous Arthritis Simulating Rheumatism.—Melchior[16] reports an interesting case of this kind, and says that the condition was described some years ago by Poncet and also by Grocco. The arthritis differed from that found in rheumatism, in that there was a more sub-

acute onset than in rheumatism, less fever and pain, no sweating, and no erythema of the skin over the affected joints. It is found generally in patients with a tuberculous focus elsewhere or who have been exposed to tuberculosis. Later the joint inflammation disappears, but occasionally there may be a chronic tuberculous joint, with considerable fluid or tuberculous nodules within the joint. In his case Melchior found tubercle bacilli in the blood. The condition should be differentiated from acute rheumatism and from acute tuberculous joints associated with an acute miliary tuberculosis.

Tuberculous Peritonitis.—Florio[17] obtained excellent results in the treatment of tuberculous peritonitis by the injection of sterilized air. He injects about as much air as would be equivalent to the quantity of ascitic fluid withdrawn, about 4 quarts in the first case. The air was all absorbed in twenty-three days, and there was no further trace of the effusion during the following three years, the patient continuing his work on a farm. In the second case nearly the same quantity of fluid was removed and air injected, all of which was absorbed by the thirteenth day. The patient, a woman, thirty-one years of age, was in good health during the remaining two years. In the third case the air was not injected until the patient, a multipara of twenty-eight years, had been tapped twice, the effusion soon recurring. After the injection of 1½ quarts of air there was no return of the ascites. The air was absorbed in six days. She was seen, after an interval of two years, in the best of health. In all these cases medical measures of various kinds, used before the injection, had failed entirely to benefit the patient. Florio thinks that the injection of air seems to answer practically the same purpose as a curative laparotomy in this disease, while it is free of the dangers of a major operation.

Evler[18] has applied to tuberculous peritonitis the principle of autodrainage, recently introduced in the treatment of hydrocephalus. In a case with recurring ascites and the peritoneum covered with nodules he separated the recti muscles and sutured the peritoneum between them, but closed the skin wound entirely above it. In this way a permanent opening was made between the peritoneal cavity and the subcutaneous layer of the abdominal wall, through which the ascitic fluid was diverted from its normal course and an autotherapy induced. Immediate improvement was observed, the ascites did not recur, the patient gained 25 pounds in weight, and seems to be cured, although, Evler says, she still has some cough and pain in the chest and back, as before the operation.

Aruliani[19] gives striking evidence of the close relationship between alcoholism, on the one hand, and cirrhosis of the liver and tuberculosis on the other. The portion of Italy where he practices is a wine-growing region, where wine is drunk by the inhabitants almost exclusively, the alcohol content ranging from 13 to 15 per cent. Notwithstanding the pure air, robust constitutions, and absence of poverty in the region, cirrhosis of the liver and all forms of tuberculosis are very prevalent.

Urogenital Tuberculosis.—Sawamura,[20] after an extensive study of this subject, assumed that in primary urogenital tuberculosis the process begins usually in the kidney, and extends through the ureter to the bladder and prostatic urethra, and through the vas deferens to the testicle. It may, however, begin in the testicle and extend in the reverse direction, or, beginning in the seminal vesicles, it may extend in both directions to the testicles and the kidneys. According to the literature, it is agreed that the process often begins in the kidney, and that the bladder may become infected in time, although, to a certain extent, a sound mucous membrane can protect the bladder. When tubercle bacilli are injected into the ureter, and especially into the renal pelvis, tuberculosis of the kidney can be produced with or without ligation of the ureter, although the latter undoubtedly favors its development. The infection must pass by the blood, the lymph, or the ureter. The blood-path is excluded, because by it a general tuberculosis is produced. Sawamura carried out experiments on dogs to determine the path of extension. He failed to find that the tubercle bacilli ascended from the bladder through the ureter to the kidney. By direct injection of the bacilli into the lumen of the ureter, without obstruction of the latter, a renal tuberculosis was produced. Vesical or genital infection may rarely reach the kidney by the lymph paths. It may ascend from the bladder to the kidney if, from contraction of the bladder, a relatively high internal pressure is produced, and in any manner an antiperistaltic movement of the ureter occurs. Tuberculosis of the lower end of the ureter may produce the necessary obstruction, stagnation, and dilation to permit the bacilli to reach the kidney. That the process may ascend by the lymph paths cannot be denied, although it has never been established with certainty in men or animals. Tuberculosis of the testicle or epididymis, as a rule, extends through the vas deferens toward the urethra. More rarely it may extend by the lymph paths, and it may remain localized in the testicle and epididymis. Tubercle bacilli in the urine may infect the adjacent portion of the vas deferens and the infection may reach the epididymis by the vas, provided the orifice or lumen is blocked, the stagnated secretion and exudate transporting the tubercle bacilli to the epididymis. Extension from a tuberculous epididymis, with participation of the vas deferens, did not occur in Sawamura's experiments, although Oppenheim and Law and Hausen considered this possible. A primary focus of tuberculosis can develop in the prostate, may involve the seminal vesicles, and probably will involve the epididymis.

Young[21] reports the results of his experiments on 33 dogs, to substantiate his previous assertion that genital tuberculosis in the female may be due to an ascending infection. The inoculations of tuberculous material were made either into one uterine horn or into the vagina, under such precautions as would prohibit direct injection into the uterine cavity. He was able to demonstrate five instances of true ascending tuberculous infection. Engelhorn (in the same issue of this journal, p. 775) offers further proof of the possibility of an ascending

infection. Following the injection of carmin into the vagina the rabbits were killed at varying intervals, and the pigment could be plainly seen in the mucosa, muscularis, or subperitoneal tissue, depending upon the length of time elapsing after the injection. In the human, hematogenous infection is the rule; in rare cases a primary ascending genital tuberculosis undoubtedly exists.

Human and Bovine Tuberculosis.[22]—At the present time the evidence is that the bovine and human tubercle bacilli are different; that bovine and human tuberculosis are reciprocally infective; and that, subject to certain qualifications, bovine tuberculous infection is fairly frequent in man.

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CHAPTER XCIV.

SYPHILIS.[1]

By Edward Martin, M. D.,

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With Metchnikoff's[2] discovery that syphilis is inoculable upon anthropoid apes, Schaudinn and Hoffmann's[3] announcement of a specific bacterium, Wassermann, Neisser and Bruck's[4] publication of the adaptation of the Bordet-Gengou phenomenon of complement fixation to the diagnosis of syphilis, and Ehrlich's[5] creation of a new and potent remedy against infection, some of the accepted beliefs regarding syphilis have been materially modified; not, however, to the extent of negativing the vast amount of knowledge gained by accurate clinical observation, nor of putting entirely aside the well-proved and standard methods of treatment which, when systematically and carefully carried out, have accomplished such satisfactory results.

Treponema Pallidum.—Schaudinn and Hoffmann describe the Treponema pallidum (spirochæta, spironema) as a thin, motile, markedly spiral organism 6 to 15 mm. in length, with numerous and very regular undulations, which are retained both while at rest and in motion. The poles are ciliated, a doubling at times noticeable at one end, indicating, according to Schaudinn, longitudinal division. These microorganisms are present in all syphilitic lesions, regardless of their period of development. They are most readily found in the mucous patches and condylomata of the secondary period and in the primary chancre. The proof of their presence in tertiary lesions is afforded by animal inoculation, since their microscopic detection is difficult.

After inoculation there is probably a fairly rapid dissemination of the infecting organisms. In their distribution through the system they particularly affect the lymph- and blood-vessels and their perivascular environment. Their recovery from the blood is difficult. They are found in the bone-marrow, the testicles, ovaries, in every vascularized part of the body, even in the cartilage. In early hereditary syphilis they are present in enormous numbers. They have been recovered from the saliva, the urine, the bile, but not from the spermatic fluid, although inoculations of this fluid obtained from a

[1] Supplementary to Chapter XX., Vol. I., p. 675.

[2] Études Expérimentale sur la Syphilis Prém. Mémoire Annales de l'Institut Pasteur, 1903, xvii., p. 809.

[3] Arbeiten aus den k. Gesundheitsamte, 1905, vol. xxii., p. 527.

[4] Deut. med. Woch., 1906, No. 19, S. 745.

[5] Alt. Münch. med. Woch., No. 11, March 15, 1910, p. 56.

syphilitic give positive results. Efficient specific treatment is characterized by prompt disappearance of the spirochætes from the lesions as a prelude to rapid healing.

Diagnosis.—Noguchi[1] assigns to Schereschewsky[2] the credit of having first demonstrated culture of Spirochæta pallida on artificial media, though he was unsuccessful in obtaining pure culture. Mühlens and Hoffmann succeeded in procuring pure strains, but were unable to reproduce syphilitic lesions in animals by inoculation.

Noguchi employed rabbit testicle which had been inoculated with material obtained from the human. Following such inoculation there is a two weeks' incubation period. Thereafter the testicle slowly swells and exhibits the pallida in an enormous number. By transmitting a strain from this first generation at appropriate intervals any number of generations can subsequently be derived. Moreover, these strains are practically pure.

The only suitable medium found by Noguchi was serum water, to which was added a piece of sterile rabbit tissue, preferably a portion of the kidney or testicle. The liver was found unsuitable. Strict anërobic conditions were found of vital importance in obtaining the first generation of the pallida. A slightly alkaline reation was also found needful, the temperature being between 35° and 37° C. These conditions are particularly essential to the first generations, later generations seem to develop a certain adaptability to artificial media. Inoculation of pure strains into the testicles of rabbits produce typic lesions, with an abundance of pallida.

In the hope of demonstrating a specific cutaneous reaction for syphilis, Noguchi[3] ground into thick paste agar columns containing spirochæta and diluted this by adding fluid culture of the same organism. This fluid was heated to 60° C. for sixty minutes and 0.5 per cent. carbolic acid was added. The dark-field microscope showed from 40 to 100 dead pallida to a field. Culture of this suspension remained sterile, nor with it could infection be produced in the testicles of rabbits. This preparation Noguchi calls luetin.

After some preliminary animal experimentation the skin reaction was applied to 400 cases, 177 of which were of syphilitic nature, 77 were parasyphilitic, and 146 represented controls. The emulsions were injected intradermically, raising the epidermic layer up sharply and producing a welt which lasts for from ten to fifteen minutes. A small erythematous area develops after twenty-four hours, which in control disappears in the next two days without induration.

In syphilitic and parasyphilitic patients there is a distinct reaction, most constant and severe in tertiary and hereditary affections. Noguchi states that it is constantly present in the manifest tertiary affections—in 94 per cent. of late, and in 96 per cent. of latent, tertiary affections. During the primary and secondary stages the reaction is in-

[1] Jour. Exp. Med., Aug., 1911.
[2] Deut. Med. Woch., 1909, xxv., pp. 835–1260 and 1652.
[3] Jour. of Exp. Med., Dec. 1, 1911.

frequent, excepting when energetic treatment has been or is being carried out and clinical signs of syphilis are absent; such cases may show a severe reaction.

The positive reaction may appear in the papular form in from twenty-four to forty-eight hours, a telangiectatic zone of redness surrounding the papule induration, increasing for three or four days and disappearing in a week. The pustular form resembles the papular at first, but exhibits central softening, going through a vesicular and finally the definitely purulent stage. The torpid form gives at first an apparently negative reaction, but after some days lights up and progresses to small pustulization.

If Noguchi's tentative conclusions as to the constancy and the specificity of the reaction be corroborated by clinical trial there will be added to our diagnostic methods one of incalculable benefit, since to the surgeon the diagnosis of syphilis is of importance mainly in its tertiary and its latent forms. It is particularly in such forms that the largest percentage of negative Wassermann reactions are found, while in them a characteristic dermal reaction is most constant.

The **Wassermann reaction** is serviceable from the diagnostic, therapeutic, and prognostic standpoint. It is not a specific antigen antibody reaction, but rather one incident to the action of an antibody with non-specific antigens.

In carrying out the test complement, antibody, antigen amboceptor, and red blood-cell suspension are required. Complement is derived from guinea-pigs' blood-serum, this animal being used because of the fixability and comparatively quantitative constancy of its complement; its unit is determined.

The amboceptor or hemolysin is obtained from the blood of rabbits which have been previously injected with washed sheep corpuscles (Noguchi, human red blood-cells). It is titrated before use, for the purpose of determining the smallest dose which will give complete hemolysis with 5 per cent. suspension of red cells and 1 unit of complement (Noguchi, 1 per cent. of human cells and 1 unit of complement). Twice that dose will be the amount required for the test.

The cell suspension is a 5 per cent. mixture of washed sheep erythrocytes (Noguchi, human) in 0.9 per cent. chemically pure salt solution.

The antibody is obtained from the patient's blood: 5 to 10 c.c. are drawn from the median basilic vein.

The Wassermann antibody is the watery extract of a syphilitic fetal liver. The fractional alcoholic extract of normal liver or heart tissue is now used.

The test is made by incubating a mixture of antigen (extract of liver or heart tissue), antibody (patient's serum), and complement (guinea-pig serum). If the patient's serum is syphilitic its antibody, in combining with antigen, will use up the complement, and there will be none of the latter left. To determine this, suspension of red cells and their specific hemolysin (rabbit serum rendered hemolytic to these red

cells) are added. If the complement has not been used up by the first test, it will complete this hemolytic system and cause solution.

In the practical application of this test numerous controls are essential, nor have its results the slightest value, except when obtained by trained laboratory workers who have had large experience with the method.

Dr. Ellen Corson White,[1] basing her conclusions upon recent literature and upon 5433 cases which she examined simultaneously by Wassermann, Bauer, and Noguchi methods, records positive reactions—in the entire list of specific cases—62 per cent. with the Wassermann and 71 per cent. with the Noguchi technic.

In primary syphilis the reaction appeared, as a rule, in from ten to twenty days after the initial sore, and increased in intensity until the appearance of the roseola or until the disease was modified by treatment. The percentage of positive results in the first examination of primary syphilis was 81, while the percentage in the later examinations was 98.

In secondary syphilis the reaction was practically always positive, 98 per cent. In tertiary syphilis the percentage was slightly lower—Wassermann, 79 per cent.; Noguchi, 84 per cent.—the loss probably being due to the treatment received by the patient.

In definitely latent cases, and in cases after a prolonged course of treatment, the number of positive results falls much lower—Wassermann, 43 per cent.; Noguchi, 56 per cent.

In definite cases of hereditary syphilis both reactions gave 100 per cent. positive results. In some defective children nothing clinical was found except the mental or physical retardation and the Wassermann reaction. In 35 mothers with still-births, 19 gave positive results, and in 32 mothers of frankly syphilitic children, 27 gave positive results.

In all cases of frank syphilis, with no involvement of the nervous system, the complement fixation reaction is found only in the blood-serum and never in the cerebrospinal fluid. When the nervous system is involved the antibodies appear also in the spinal fluid.

In cases of cerebrospinal syphilis a positive reaction occurs in the blood-serum of the majority of the active cases, and may be weakly present in the cerebrospinal fluid or absent with the ordinary amount used in the test. This is a differential diagnostic point between cerebrospinal lues and paresis. In the latter equally strong reactions occur in both blood-serum and cerebrospinal fluid—98 per cent. A negative reaction in these fluids is very strong presumptive evidence against general paralysis.

Aside from the cases of definite syphilis, positive results occur frequently in frambesia, trypanosomiasis, mixed and tubercular leprosy. Michaelis has reported some positive results in malaria; Much and Eichelberg, in scarlet fever; Bass, in cases of pellagra; and others obtained positive tests in cases of tuberculosis and carcinoma. In scarlet fever the reaction is transitory, and but a very small percentage of the cases

[1] Personal communication.

give it. A few cases of reaction in tuberculosis may be explained on the basis of mistake in diagnosis or a mixed infection.

Dr. Corson White holds, as a logical deduction from this study, that positive Wassermann reaction means syphilis, and a negative Noguchi reaction means no syphilis in the great majority of cases.

To this, exception justly can be taken. The surgeon is little concerned with the diagnosis of either primary or secondary syphilis, nor, indeed, with that of the tertiary manifestations of the disease when they are obvious, either from a clear history or from the characteristic clinical manifestations. Atypic lesions occurring in the late tertiary period, or as an evidence of latent syphilis, are those which are commonly referred to him, and these are the cases in which the Noguchi and the Wassermann tests give the largest percentage of failures. Hence, in individual instances far less importance should be attached to a negative than to a positive reaction.

As a test of cure, the findings of the Wassermann reaction must be accepted with reservation. Mercury or salvarsan may cause either a temporary accentuation or diappearance of the reaction, or, in the case of the latter drug, a reaction previously negative may become positive. As a rule, patients under efficient mercurial treatment give negative Wassermann reactions. A single injection of salvarsan may change a positive Wassermann to a negative in one week, usually in six.

Craig and Nichols[1] note that the ingestion of alcohol (200 c.c. of whisky) will convert a positive to a negative reaction for from one to three days.

Repeated negative reaction, in the absence of specific treatment, may be interpreted as indicating the probable absence of infection; repeated positive reaction, as an index of its presence.

From the therapeutic standpoint, in the primary, secondary, and early tertiary stages of the disease, the effort should be made to change by vigorous treatment a persistently positive reaction to a permanently negative one. In late tertiary stages this effort will probably be unavailing, and, in the absence of demonstrable lesions, may be hurtful rather than beneficial. This is particularly true of parasyphilis.

From the prognostic standpoint, a persistent Wassermann indicates at least the possibility of the vascular scleroses which lead to cardiovascular break down and degeneration of the central nervous system.

Salvarsan, the dihydrochlorid of dioxydiamidoarsenobenzene (often called "606"), is given intravenously in clear alkaline solution. This is made in each case, immediately before it is to be used, by shaking the desired dose of the drug, usually 0.6 gm. with 40 c.c. *freshly prepared* and *sterilized* physiologic salt solution (0.9 per cent.), both the water and salt used being chemically pure. Loose glass beads in the mixing jar facilitate this solution, which is acid and clear. To render it alkaline and clear there is added 1 c.c. of 15 per cent. sodium hydrate solution. To the resultant cloudy suspension the sodium hydrate solution is therafter added a drop at a time, each drop being followed

[1] Jour. Amer. Med. Assoc., Aug. 5, 1911.

by vigorous shaking until the suspension becomes a clear solution. Enough freshly prepared hot, sterile physiologic salt solution is then added to make 300 c.c. Each 50 c.c. contains 0.1 gm. salvarsan. The solution, at a temperature of about 45° C., is poured into a graduated Thermos buret, the rubber tube leading from which is provided with a nozzle which fits into a stop-cock, which in turn screws into the needle used for venous puncture. A second buret, containing hot physiologic salt solution, should be provided. The platino-iridium needle employed has a slightly larger lumen than that of the ordinary hypodermic syringe. The vein of choice is made prominent, the skin is punctured at the desired point by a quick stab with a cataract knife, the needle is passed through this puncture and into the vein lumen, its proper position being tested by allowing 10 to 20 c.c. of normal salt solution to flow through it. The salvarsan buret is then connected and the rate of flow, 300 c.c. in not less than ten minutes, regulated by the height of the container. There is a final flush with salt solution and the needle is withdrawn. If the vein be difficult to reach by the needle, it should be exposed by incision under local anesthesia, when the injection is made through the needle or an ordinary vein cannula.

In the preparation of the solution, the vessels and instruments used, the surgeon's hands, and the skin of the patient the principles of surgical cleanliness must be rigidly observed.

Neither immediately nor thereafter does a successful intravenous injection cause more than a slight local soreness. Infiltration of the subcutaneous tissues with the salvarsan causes severe pain, and at times tissue necrosis and persistent ulcers.

There is no immediate systemic effect; in the course of from one to six hours there may be malaise and anorexia, or chill, fever, vomiting, and diarrhea. In from ten to twenty-four hours the patient generally feels as well as he did before his injection, and in from three to fourteen days very much better. There is not infrequently a condition of malaise and depression lasting one or two weeks. The depressing effect of a first dose is not necessarily indicative of a similar effect on repetition of the treatment. Nor does absence of undesirable reaction at one time insure against its development at another.

Exceptionally, following an injection, patients are exceedingly ill, circulatory and respiratory disturbances developing rapidly, or those suggesting acute yellow atrophy of the liver in a few days. Some fatalities are recorded, and many have doubtless occurred which have not been deemed worthy of record.

Even though allowance be made for these unreported fatal cases, it is clear that, considering its arsenic content and the quantity thrown into the blood-stream, the mortality is an astonishingly small one, and in carefully selected cases reaches almost the vanishing point.

The dosage of salvarsan, now rarely more than 0.6 gm. for the strong, 0.2 to 0.3 for the weak, should theoretically be increased. Clinical evidence has, however, not shown that desired results are proportionate to the size of the dose. The injection is repeated at least once in prac-

tically all cases; when symptoms recur many repetitions may be needful. Since elimination is completed within a week, a further administration is as safe then as at a later period, in so far as cumulative effect is concerned.

Salvarsan is indicated in all stages of syphilis. Given in full dosage and repeated in seven days it produces its maximum safe effect, and if used in the early stage of chancre seems capable of producing an immediate and permanent cure. The lesions of syphilis yield more promptly to salvarsan than they do to mercury, and the Wassermann reaction becomes negative in a larger proportion of cases. The drug is efficient in cases in which mercury seems harmful rather than the reverse, as in malignant and severe hereditary syphilis. It is futile against the remote effects of a one-time active tissue reaction against the spirochetal infection, hence not advisable in well-advanced locomotor ataxia, progressive paresis, or long-standing cardiac and vascular degenerations. Nor has it proved demonstrably serviceable in patients in the late tertiary periods of the disease, in whom no sign or symptom of syphilis is present except the persistence of a feebly positive Wassermann reaction. Neither eye nor ear involvement, nor non-specific lesions of these organs have been shown to be contraindications to the treatment, nor, indeed, any lesion of the active disease. Known idiosyncrasy toward arsenic would at least suggest an initial minimum dose.

A profound depreciation in vital resistance, characterized by the term cachexia, whether originally it be of syphilitic or non-syphilitic origin, and long-standing extensive involvement at the circulatory, respiratory, central nervous, or secretory and excretory systems, constitute in themselves contraindications to a vigorous salvarsan treatment, the single exception to the rule being found in certain cases of exceedingly virulent syphilis in which the cachexia is obviously due to the active infection.

It is generally accepted that salvarsan should be supplemented by mercury, the latter being given in doses as large as are compatible with bodily and mental vigor, preservation of appetite and digestion, free elimination, and the holding of the normal weight.

CHAPTER XCV.

TUMORS.[1]

By Sir John Bland-Sutton, F. R. C. S., Eng.,
London.

Tumors of Ductless Glands.—From the earliest times man has recognized that the genital glands—ovaries and testicles—exercised an important influence on the growth and development of the body. Among agriculturists this knowledge is turned to practical account, for the gelder and spayer is a well-known person in rural districts. Ablation of the testicles and ovaries in young animals and birds is performed for the purpose of allowing them to grow fat, and, coincident with the fattening, animals which have had these organs removed when young often attain a larger size than their non-castrated companions. This is true of men, for the eunuch is large in bone as well as fat.

The effects of the complete removal of the genital glands from young animals are of two kinds. The animal remains infantile, and there is an abundant deposit of subcutaneous fat.

Infantilism consists in the stunted growth or non-development of sexual attributes. In boys the sexual attributes consist of an alteration in the voice, due to increase in the size of the larynx and the consequent lengthening of the vocal cords, and a growth of hair on the face and pubes. In girls the changes consist of enlargement of the breasts, the appearance of hair on the external genital organs, and the establishment of menstruation.

In the temperate zone the usual age at which children become sexually mature, or pubic, is about fourteen. The signs are occasionally late in appearing—*delayed* puberty. Occasionally they are manifested very early; this is known as *precocious* puberty.

It has been known for a long time that certain organs are liable to be the seat of tumors, associated with abnormal development of hair (hirsuties) and precocious puberty. Moreover, the organs exercising this extraordinary influence are essential to life, for their complete ablation is followed by a peculiar train of symptoms ending in death. Two ductless glands exercise this influence in a remarkable degree; namely, the hypophysis cerebri (pituitary body) and the adrenals or suprarenal capsules. The thyroid gland is, in some way, correlated with the sexual organs, and this indefinable association has been recognized from time immemorial. The temporary enlargement of the

[1] Supplementary to Chapter XXI., Vol. I., p. 735.

thyroid at puberty and during pregnancy is physiologic, and meets the needs of the body for an increased supply of thyroidal secretion. Care should be taken not to interpret these sudden enlargements as due to disease and interfere with them by operation, for they gradually subside. The complete removal of the thyroid gland leads to the curious connective-tissue disease, myxedema.

Tumors of the Parathyroids.—Closely connected with the thyroid gland are the small bodies known as parathyroids, detected by Sandström in 1880; their complete ablation is probably incompatible with life. The parathyroids are of interest to the surgeon because they occasionally enlarge and behave like tumors.

Often four parathyroids are present, attached to the branches of the thyroid arteries (Fig. 9); it is easy to realize that should one or other of these bodies enlarge it would compress the trachea.

FIG. 9.—THE LARYNX AND GULLET SEEN FROM BEHIND.

The illustration shows four parathyroid bodies in relation with branches of the thyroid arteries.

Some years ago a man was found by a policeman lying in the street. By the time he was conveyed to the Middlesex Hospital he had died. At the postmortem examination a tumor somewhat larger than a dove's egg was found compressing the trachea between the

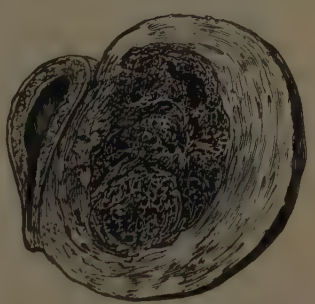

FIG. 10.—THE TRACHEA IN SECTION.

It is flattened like the sheath of a saber by a tumor which arose in a parathyroid. From a man who died suddenly. (See Text.)

fourth and ninth semirings (Fig. 10). At the time I considered the tumor to be an enlarged accessory thyroid.

When we knew more about the parathyroids, I re-examined the tumor microscopically, and came to the conclusion that it was an enlarged parathyroid. Sixteen years later I removed a similar tumor from a young married woman. On her way home from India, when in the Red Sea, she began to experience difficulty in breathing, and a small rounded tumor was detected in her neck below the thyroid gland; this increased in size, and the dyspnea became so urgent one night that the ship's surgeon remained by her bedside prepared to perform an immediate tracheotomy. The swelling subsided and the operation was avoided.

Subsequently I removed this tumor; it was as big as a cherry and firmly adherent to the side of the trachea. She quickly recovered. The tumor in its minute structure was indistinguishable from a parathyroid. It is believed by some observers that, in addition to an undefined correlation between the thyroid gland and the genital gonads, there is some close functional association between it and the hypophysis cerebri. Although this matter has been made the subject of much close investigation by histologists, physiologists, experimental pathologists, and physiologic chemists, the precise nature of their complemental functions remain undetermined. The results of the investigations on these organs

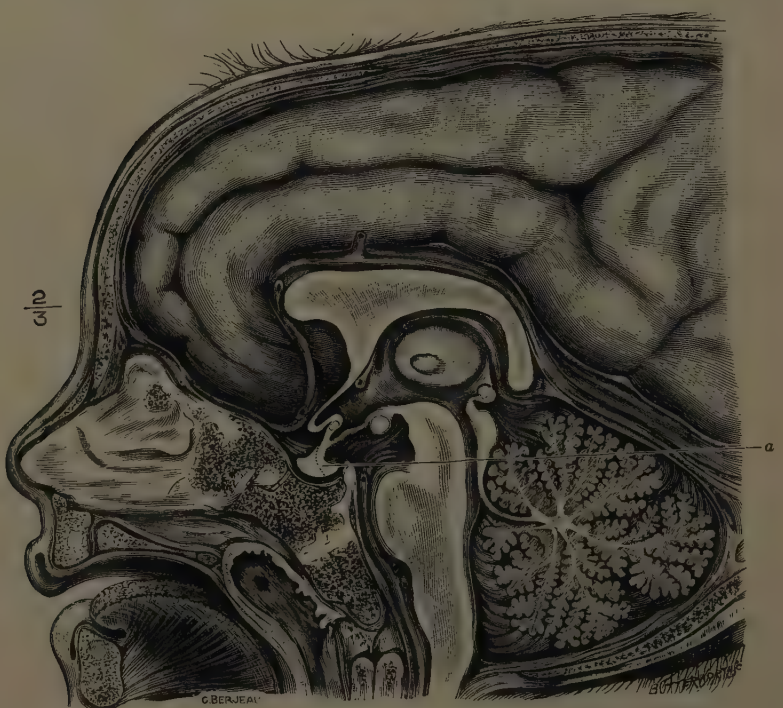

FIG. 11.—THE HEAD OF A CHILD IN SAGITTAL SECTION, SHOWING THE HYPOPHYSIS CEREBRI. (Museum Royal College of Surgeons, England.)

The dotted line on the cut surface of the hypophysis (*a*) indicates the position of the intermediate tissue, separating the anterior from the posterior lobe. The communication of the infundibulum with the intraventricular cavity is well shown.

are of profound interest to all who study medicine or surgery, and some of them will be considered.

Tumors of the Hypophysis.—The hypophysis is a glandular body, about the size of a small pea, connected with the base of the brain by a hollow stalk, known as the infundibulum; it is lodged in a pouch of dura mater, which occupies a depression in the sphenoid bone, known as the sella turcica.

The hypophysis consists of two lobes. Of these, the anterior is the larger, and, on microscopic examination, exhibits a structure not

unlike that of the thyroid gland, for it presents loculi lined with epithelium and is vascular. The posterior or smaller lobe is lodged in a depression on the posterior surface of the anterior lobe; it receives the infundibulum. The dural pouch, occupied by the hypophysis, is separated from the subdural space by a fibrous septum, known as the operculum or tentorium of the hypophysis. In the skulls of children a fibrous ligament passes from the dura mater lining the floor of the pituitary fossa through the body of the sphenoid to the roof of the membranous pharynx. In the macerated skull the space occupied by this ligament is known as the craniopharyngeal canal. In good skiagraphs of the skull in young adults the pituitary fossa is often conspicuous.

Although the glandular portion of the hypophysis appears as an appendage to the brain, and its stalk or infundibulum belongs to this organ, the important secreting portion strictly belongs to the pharynx. In the early embryonic stages the infundibulum, a hollow process of the prosencephalon (first primary encephalic vesicle), comes into relation with a diverticulum from the stomatodeum (primitive pharynx). This diverticulum is sometimes named after the celebrated embryologist who detected it, the pouch of Rathke (1883), and is nipped off by the developing base of the skull; the portion thus detached becomes incorporated with the terminal portion of the infundibulum. Accessory hypophyses are sometimes found in the craniopharyngeal canal, and also in the roof of the pharynx around Rathke's pouch.

Physiologically, the anterior lobe of the hypophysis, the portion derived from the primitive pharynx, is an internal secreting gland. The posterior lobe and the infundibulum, consisting of ependymal and epithelial cells, apparently pours its secretion into the cerebral ventricular system through the third ventricle. Sometimes the hypophysis is described as consisting of two lobes, of which the anterior is called the secreting or glandular, and the posterior the nervous, lobe.

The history of the importance of this body begins with the discovery by P. Marie, in 1885, that the disease, to which he gave the name acromegaly, characterized by a conspicuous overgrowth of the hands, feet, head, and face, was associated with great enlargement of the hypophysis. A large number of observations have been accumulated since that date which support the conclusions arrived at by Marie in his original essay.

It is admitted that in all cases of acromegaly which have been examined postmortem, enlargement of the hypophysis has been noted; it is also equally true that tumors of this organ have been found in patients who have not manifested signs of acromegaly.

In the most typic cases of acromegaly the enlargement of the anterior lobe of the hypophysis seems to be an overgrowth or hypertrophy of its secreting cells, resembling the changes seen in an enlarged thyroid or parenchymatous goiter. The changes are, indeed, so similar that one writer (Shattock) suggests the term pituitary goiter for such an enlarged hypophysis.

The gradual enlargement of the hypophysis exercises certain local

effects which give rise to a definite set of symptoms of great clinical importance, for its position in the interpeduncular tract brings it into intimate relation with the optic tracts and the crura cerebri.

The fossa in which the hypophysis is lodged measures about 10 mm. in its sagittal axis, 14 mm. transversely, and about 8 mm. in depth. In pronounced cases of acromegaly the enlargement of the hypophysis leads to absorption of the surrounding bone, and its fossa becomes a broad, shallow depression. In some skulls the floor of this fossa may become so absorbed that the enlarged hypophysis rests on the mucous membrane of the pharynx. The effects on the cerebral structures are equally pronounced, and the optic tracts and the crura cerebri are flattened and compressed. The clinical signs resulting from this pressure are fairly constant—persistant headache and bitemporal hemianopsia.

With the assistance of the *x*-rays the absorption of the bony walls of the sella turcica can be made manifest. The local effects of enlargement of the hypophysis form a striking picture of the effects of environment in regard to symptoms.

The physiologic effects are very remarkable, for if the hypophysis enlarges during adolescence the individual becomes a giant, and it is now definitely proved that Hunter's famous giant, O'Brien, was acromegalic. He died at the age of twenty-two. His skeleton (in the Hunterian Museum of the Royal College of Surgeons, London) is 7 feet 8¼ inches high, and the expanded condition of the sella turcica shows that it had been occupied by a big pituitary body. When this body enlarges in an adult it produces the peculiar big hands, feet, head, and face characteristic of acromegaly. Polyuria and, occasionally, diabetes occur.

These facts indicate that the hypophysis furnishes a secretion which exercises an important influence on the growth and development of the body. Experimental removal of the hypophysis in animals leads to depression, coma, and death. Inefficient function of this gland in men and women leads to an abnormal deposition of subcutaneous fat, loss of sexual power, and the genital glands revert to the infantile type; amenorrhea occurs in adult women. In men this sexual disability is sometimes styled "pituitary eunuchism." It is now the custom to speak of the effects produced by an enlarged pituitary body as "hyperpituitarism"; they are "giantism" in young, and "acromegaly" in adult, individuals. Defective action of the gland is "hypopituitarism," and is manifested by a rapid deposition of fat in the subcutaneous tissues, a persistence of the juvenile type of genital organs in young individuals, and a loss of sexual function in adults.

There is a physiologic foundation for such opinions. Physiologists recognize three parts in the hypophysis: an anterior lobe, a posterior lobe, and a pars intermedia situated between the two lobes. Experimental removal of the whole gland is followed by muscular weakness, dyspnea, emaciation, and death. The anterior lobe resembles in structure the fetal thyroid; its removal leads to genital infantilism. The

hypophysis enlarges after removal of the thyroid or the adrenals, and after castration. Extract of the hypophysis when injected intravenously causes a rise of blood-pressure. Experiments with extracts show that the effects vary according to the part of the hypophysis from which it is prepared.

Interaction between the pituitary body and the sexual organs sometimes leads to temporary acromegaly during pregnancy. A primipara, aged twenty-six, had advanced to the eighth month, when she noticed that her gloves and boots became too tight. Her fingers thickened and the rings upon them had to be removed with a file. She became sleepy and thirsty; sugar appeared in the urine. Gradually she assumed the coarse skin, thick lips, and projection of the lower jaw characteristic of acromegaly. The child survived its birth, and in a few months the signs of acromegaly in the mother disappeared (Marek).

It is important to realize that acromegaly only arises in connection with certain tumors of the hypophysis, more especially with those which appear to be due to hypertrophy or adenomatous enlargement of this body. This matter has been emphasized by Purves Stewart (1909); he published the details of 4 cases, and collected 20 others, in which a histologic examination of the tumor was made. In 17 of these cases there were no signs of acromegaly. The tumors which occur in connection with the hypophysis receive a variety of names at the hands of the recorders, such as adenoma, sarcoma, carcinoma, adenosarcoma, epithelioma, endothelioma, psammoma, pituitary goiter, and cysts.

The tumors which produce the most typic symptoms are those due to the definite enlargement of the gland, accompanied by a regular expansion of the sella turcica. Such are almost invariably associated with acromegaly.

The tumors classed as sarcomata erode the body of the sphenoid rather than produce its slow absorption.

Teratomata occasionally arise in connection with this part of the sphenoid and bulge into the pharynx. These tumors have a morphologic interest, as the sella turcica marks the anterior (cephalic) termination of the axis of the trunk. It is a region which bristles with many morphologic, embryologic, and evolutionary problems.

Many observers in recording cases of hypopophyseal tumors have expressed surprise at the few symptoms which even large tumors arising in connection with this body produce. In common with other intracranial tumors, those arising from the hypophysis produce mental dulness, hebetude, drowsiness, and mental lethargy. It is, however, a clinical feature in connection with them that a patient, after lying several weeks in a drowsy condition, will suddenly wake up and appear to the relatives quite rational. A man of this kind, under Ferrier's care, would pass his time asleep in a chair and resent being disturbed. He suddenly had a "lucid interval, during which he woke up and made a perfectly sensible will." Reissmann, in reference to a woman with a hypopophyseal tumor, who had become a hopeless imbecile, writes: "One day on being summoned to her bedside I was astonished to find

her with her old familiar expression, perfectly rational. She knew me and immediately conversed with me intelligently. The following day she became drowsy, the drowsiness deepened into coma, and a week later she died."

The divergent effects, local and general, attributed to tumors of the hypophysis may be explained. Every tumor which occupies the sella turcica is not necessarily a tumor of the hypophysis. It is well known that many malignant tumors growing in the testicle do not arise from the intrinsic elements of that organ; indeed, the greater proportion originate in the band of tissue known as the paradidymis. As the tumor grows the tubular seminiferous tissue is flattened out like a strap (Fig. 13, p. 123). Similar changes probably occur in the hypophysis. A tumor growing from the dura or other membranes of the brain, the periosteum of the sella turcica, or the infundibulum would compress and flatten out the hypophysis to a thin, inconspicuous stratum. Moreover, a growth in the posterior, or so-called nervous lobe, would flatten out the anterior lobe, and *vice versâ*.

The whole question is very complex; for example: A man aged fifty died in the Middlesex Hospital with a sarcoma growing from his sternum. The lymph-nodes in each axilla were enlarged. Masses of sarcomatous tissue occupied the posterior triangles of the neck and extended upward into the pterygomaxillary regions. As the body lay on the table, Cecil Rowntree, who conducted the autopsy, noticed that the hands were unusually large; the big toes were large, out of proportion to the other toes. The lower jaw was prominent and the nose big. The general appearance was so like that of the early stage of acromegaly as to induce Rowntree to ask some of his colleagues to inspect the body. The hypophysis was small, and its anterior portion contained a deposit of white new-growth, which appeared to have no connection with anything else beyond the dura lining the floor of the pituitary fossa. The tumor mass in the left pterygomaxillary fossa had eroded the great wing of the sphenoid, but had not penetrated the dura. The primary dura in the sternum was a mixed-cell sarcoma in which small spindle cells predominated. The growth in the anterior lobe of the hypophysis exhibited the same minute structure.

Removal of Hypophysis Tumors (Hypophysectomy).—It might be imagined that the hypophysis lodged in a bony cave in the body of the sphenoid would be safe from surgical aggression. This is not the case; it has been attacked in two directions by enterprising surgeons; namely, through the nasopharynx and through the side wall of the cranium.

(1) *The Nasal Route.*—An incision is made in the line of the left nasofacial sulcus, which allows the nose to be reflected on to the opposite cheek. The vomer is then detached from the base of the skull; this permits the surgeon to expose the sphenoidal sinuses, and by breaking through them reaches the hypophysis. The tumor tissue is then scraped away by a scoop. The chief objection to this method is the difficulty of keeping the parts aseptic. Chiari has removed the hypophysis with success by a method devised by his assistant, Marschik,

which is an extension of the operation for evacuatory inflammatory products from the frontal, ethmoidal, and sphenoidal sinuses. An incision is made from the inner angle of the orbit over the junction of the nasal with the frontal bone, a portion of the frontal is exsected, also the middle turbinal and portions of the lamina papyracea of the ethmoid. The sphenoidal sinus is opened and this affords access to the pituitary fossa.

(2) *The Cranial Route.*—In this method the bone is freely removed from the right side of the skull, and, after opening the dura mater, the cerebrum is raised by means of retractors until the infundibulum is exposed. The enlarged hypophysis or the tumor is then removed piecemeal, with the assistance of a scoop. It is a tedious operation, and rendered more difficult on account of certain intracranial portions of the nerves which lie in close relation with it. In patients who have recovered after removal of the hypophysis the acromegalic changes have abated, and in some they disappeared. (See also p. 312.)

Tumors of the Pineal Gland.—Tumors arising in the pineal gland have been variously described as sarcomata, gliomata, psammomata, and teratomata. A critical analysis of the reported cases makes it clear that, except from the fact that the tumors lie upon the corpora quadrigemina, there is nothing to indicate definitely that many of them were tumors of this body. Those described as teratomata contain hair, sebaceous material, and occasionally cartilage. Many tumors of this kind have been reported in relation with the tentorium cerebelli, and are probably connected with the crease in the dura mater from which the tentorium develops. Psammomata are probably derived from the pia mater on the under surface of the velum; tumors of this kind are common in connection with the pia mater in the neighborhood of the great transverse fissure, the summit of which is occupied by the pineal gland. If all such are carefully excluded, tumors arising from the pineal body are excessively rare, and it would be probably more correct to describe them as tumors in the situation of, rather than tumors arising in, the pineal gland. Howell has carefully considered this question, and expresses the opinion that tumors do arise in, and remain confined to, the pineal body. They have a low degree of malignancy and do not infiltrate adjacent structure nor disseminate.

As nothing is known of the functions of the pineal gland, the disturbance caused by a tumor arising in it would be mainly due to pressure on adjacent parts; these would include the corpora quadrigemina and the Sylvian aqueduct, the optic thalami, and the veins of Galen.

Pressure on the aqueduct induces dilatation of the cerebral ventricles and accumulation of the cerebrospinal fluid, hence internal hydrocephalus is a marked feature of pineal tumors. By pressure the corpora quadrigemina are, in some cases, flattened, and this leads to pressure on the optic thalami and associated structures, so that ocular signs are characteristic and constant clinical features. Paralysis of special nerves, headaches, and occasionally auditory symptoms occur. Giddi-

ness and staggering gait are noticed in many cases. In a few cases polyuria and symptoms connected with the sexual organs have been noticed, such as occur in connection with the pituitary body. These may be probably accounted for by interference with the hypophysis due to pressure by the fluid accumulated in the third cerebral ventricle. Many of the tumors give rise to that familiar cerebellar sign, a great tendency to fall backward. This is due to pressure on the cerebellar peduncles.

Tumors of the pineal gland have been removed by surgeons so far without success. Horsley states that these surgical attacks have been made below the tentorium. He is of the opinion that if a tumor of the pineal gland were approached supratentorially it might be successfully removed.

Tumors of the pineal gland are so common that Bailey and Jelliffe, after searching the literature of a century, were only able to find records of 59 examples.

Tumors of the Adrenals (Suprarenal Capsules).—For centuries mankind has been content to believe that the manifestation of the secondary sexual characters at the advent of puberty, in men and women, depended on the ripening of the sexual organs. The two organs known as the adrenals, though conspicuous in the abdomen, were very mysterious in regard to function. The careful clinical and postmortem observations made by Addison (1885) showed that these ductless glands had some relation to a disease characterized by a peculiar pigmentation of the skin, associated with persistent vomiting, feeble action of the heart, and gradual failure of strength, ending in death. Experimental removal of the adrenals in animals was followed by similar symptoms and death. Subsequent to Addison's classic observations several physicians recorded cases in which tumors of the adrenal had been accompanied by peculiar bronzing of the skin and abnormal development of hair on the body (hirsuties). In 1905 some remarkable cases were published by Adams, Bulloch, and Sequeira, in which boys and girls, at ages varying from one to fourteen years, developed marked pigmentation, abnormal growth of hair, and precocious development of the sexual organs in association with a malignant tumor arising in one or both adrenals. The tumors exhibited the microscopic structure of that part of the adrenal cortex known as the zona fasciculata. The cortex of the adrenal is developed from the Wolffian ridge, from the same anlage as the ovary and the testis. In fetal life the adrenal is as big as the kidney; this disproportionate size is due to hypertrophy of the cortex, which begins early and continues to term (Elliott and Armour). The tumors which arise in the cortex of the adrenal are termed hypernephromata.

It seems fairly established that the functions of the adrenals are connected in some way with the growth of the body and sexual maturity; and that precocious obesity is sometimes associated with a hypernephroma and forms a clinical feature as striking as precocious puberty. Parkes Weber considers that the extraordinary development of children

associated with the presence of a hypernephroma presents two types—the precociously obese type and the muscular or "infant Hercules" type.

From a careful consideration of the subject, Guthrie and Emery came to the conclusion that precocious physical development, sexual and somatic, may be due to tumors or hypertrophy of the pituitary and pineal glands and the adrenal cortex. Premature hirsuties occurs in practically all cases of premature physical development, but is not necessarily associated with other signs of sexual maturity. The obese type of precocious development may occur in boys and girls, but the muscular type is confined to boys. It is necessary to remember that precocious development, sexual and somatic, may be unassociated with any obvious lesion of glandular organs.

FIG. 12.—A BOY FOUR YEARS AND NINE MONTHS, THE SUBJECT OF PRECOCIOUS OBESITY ASSOCIATED WITH A HYPERNEPHROMA AND ACUTE TUBERCULOSIS. (Guthrie.)

He resembles in miniature "a burly brewer's drayman."

Hypernephromata of the Kidney.—It is well known that islets of tissue, occasionally found immediately beneath the capsule of the kidney and liver (as well as along the course of the spermatic and ovarian arteries), exhibit the microscopic characters of the adrenals so closely that they have been styled supernumerary adrenals.

Grawitz made a careful investigation of some tumors of the kidney, which in their naked-eye characters resemble lipomata, and he discovered that they were like certain tumors which occasionally arise in the adrenals and are now known as hypernephromata. He believed that the renal tumors, which resembled in microscopic structure the zona fasciculata of the adrenal, arose in supernumerary adrenals. Subsequently, a large number of

cases were reported which appeared to support Grawitz's hypothesis. The tumors in question displayed all the features of malignancy, for they recurred after removal, invaded and implicated adjacent organs and tissues, and gave rise to deposits in distant organs; they are very vascular, the central parts being often the seat of extravasated blood.

At first Grawitz's view as to the origin of renal hypernephromata was received with skepticism; then there followed a disposition to regard the majority of renal tumors as hypernephromata. Recently great doubt has arisen in regard to this question. Stoerk points out that these tumors are very rare in the adrenal; that islets of adrenal tissue are most frequently found in the upper pole of the kidney, whereas hypernephromata are most common in its lowest pole. Adrenal rests occur in the liver, but so far hypernephromata have not been detected in this organ.

The opinion is gaining ground that the majority of tumors classed as hypernephromata are carcinomata arising from the epithelium of the renal tubules. I share this opinion. I devoted a large amount of time to the clinical and histologic investigation of these tumors, and came to the conclusion that they do not destroy life so rapidly as the common forms of renal sarcoma. Patients under my care from whom I have removed such tumors have been seen by me five years after the operation in good health.

Radical Orchidectomy for Malignant Tumors of the Testicle.—When considering tumors of the hypophysis, mention was made of the confusion which exists in regard to terminology. This is pardonable in relation to an organ so difficult of access as the hypophysis, but quite as much uncertainty exists in regard to tumors of the testicle. The chief feature in regard to malignant testicular tumors is the fact that the majority of them arise in the paradidymis, a sort of *pars intermedia* between the testis proper and its epididymis. These tumors have received various names, such as adenomata, sarcomata, teratomata, dermoids, chondromata, carcinomata, cystic disease, and chorion epitheliomata.

While pathologists have been endeavoring to classify these tumors, surgeons have to deal with the grim reality that many of them quickly destroy life. It is now the custom to remove them on discovery. The great difficulty of dealing with malignant tumors of the testis is the rapidity with which the local lymphatics become infected. The great size to which the lumbar lymph-nodes attain is sometimes astonishing. This has led several investigators to study the relation of the testicle to the lymphatic system by means of fine injections. The relationship of the lymphatics to the cisterna is shown in Fig. 13.

In 1909 the writer attempted to remove a testicle occupied by a malignant tumor on the principle in vogue for dealing with cancer of the breast. He excised the right testicle with its tumor and the spermatic cord as far as the internal abdominal ring. The vas deferens was ligated and divided. The abdominal wall was freely incised as high as the costal arch and all the tissues severed till the peritoneum was ex-

posed. This was turned aside, the pampiniform plexus and the sper-

FIG. 13.—TESTICLE WITH THE SPERMATIC CORD AND VESSELS REMOVED BY RADICAL ORCHIDECTOMY FROM A MAN THIRTY-ONE YEARS. (From Bland-Sutton's Tumors, 5th ed.)

The testicle is also shown in section. A cystic tumor grew between the testis and its epididymis. The secreting tissue of the testis is flattened over the upper pole of the tumor.

matic artery were stripped from the subserous connective tissue, and the vessels tied at their junction with the right renal vein and aorta

respectively. An enlarged lymph-node on the inferior vena cava was enucleated. No other nodes were found.

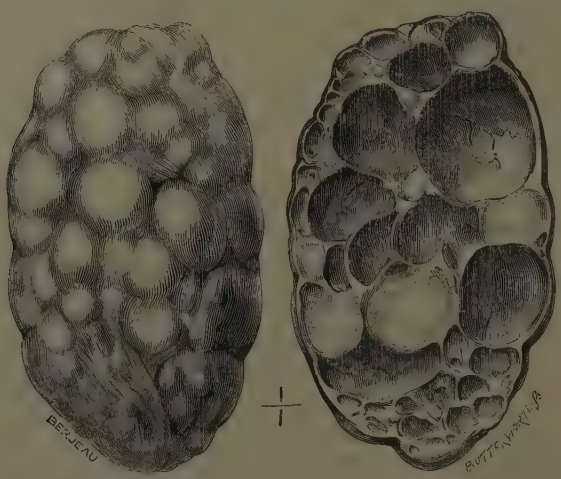

FIG. 14.—AN ENLARGED LYMPH-NODE FROM BENEATH THE ENLARGED LEFT CLAVICLE, SECONDARY TO A CYSTIC TUMOR OF THE TESTICLE. (From Bland-Sutton's Tumors, 5th ed.)

The enlargement of the testicle was due to cystic disease, and the big lymph-node from the loin exhibited the same structure. The patient recovered. Some months later a lump formed at the root of his neck on the left side. This was enucleated, and on section displayed the typic characters (naked eye and microscopic) of cystic disease as it attacks the testicle. Two years later this man reported himself in good health.

FIG. 15.—DIAGRAM SHOWING THE POSITION OF THE LYMPH-NODES ASSOCIATED WITH THE TESTICLES. (After Most.)
The results were obtained by means of fine injections.

An interesting feature of this case is the appearance of the disease in the lymph-nodes lodged in the left posterior triangle of the neck. In the description of cancerous infection of the lymphatic system (Vol. I., p. 797) attention is drawn to the mode by which the receptaculum (or cisterna) chyli becomes stuffed with cancer, secondary to a primary focus in some part of the gastro-intestinal tract, and then the cancerous cells invade the thoracic duct and convert it into a solid cancerous cord. In this way the disease reaches the cervical lymph-nodes connected

with the terminal portion of the duct. The cancerous cells do not use the duct as a conduit, but its tissues serve as a framework along which the cells find their way by permeation to the neck. It is of interest to find a tumor with so low a degree of malignancy as cystic disease of the testicle making use of such a slender cord as the thoracic duct to reach the lymph-nodes in the neck.

Malignant tumors of the testicle are fortunately not common, as the following facts demonstrate. In the year 1907 twelve testicles were removed in the chief hospitals of London for this disease. It is believed that retained testicles are more liable to malignant disease than those properly lodged in the scrotum. In 1909 I examined the material available for study in the pathologic museums in London and found 14 specimens.

Russell Howard made an examination of the records of the London Hospital, and found that during a period of twenty years 57 cases of malignant tumors of the testicle were treated in that institution; the malignant nature of the tumors was substantiated by a microscopic examination. Among this number, in 9 cases the testicle was retained in the inguinal canal. This is a higher proportion than obtains in men with normally descended testicles.

Interesting forms of malignant tumor are those which arise in the ill-developed gonads of individuals with their genitalia so malformed as to come into the class of pseudohermaphrodites. This matter has been investigated by Pick and Zacharias. Records of 35 such cases are known. The tumors have been described as sarcomata or as carcinomata. Pozzi has recently described an example which he removed from a pseudohermaphrodite (a gynandroid) aged thirty. The tumor, which weighed about five pounds, was described as a sarcoma.

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CARCINOMA.

During the last ten years some important observations have been made on the pathology of cancer which bear on the daily work of the surgeon. The chief of these will be considered in this section.

There is nothing more firmly established in regard to the natural history of cancer than the tendency exhibited by this disease to attack tissues already damaged or diseased. The liability of chronic ulcers caused by burns to become the seat of squamous-celled cancer has long been recognized, and this matter receives additional confirmation by the observations of E. F. Neve, made at the Mission Hospital, Kashmir. In an interesting contribution Neve states that during twenty years 4902 tumors were removed in this hospital. Of these, 1702 were malignant; 1189 of these malignant tumors were classed as carcinomatous, of which 848 occurred on the thighs and abdomen. This frequency is unparalleled, and is due, as Neve explained, to the use of a peculiar portable fire-basket (or kangri) by the Kashmiri. The kangri is a small earthenware pan contained in a basket. Burning charcoal is placed in the pan, and the kangri is suspended to the waist under the loose robes worn by these people as a means of keeping them warm, for the hills of Kashmir are cold. This portable fire-basket, like the hot-

FIG. 16.—THE KANGRI.

A small basket holding an earthenware pan containing burning charcoal which the Kashmiri wear strapped to the waist, beneath their garments, to keep them warm.

water bottle or the old-fashioned warming pan, often burns the skin and causes a chronic ulcer. Many of these ulcers become carcinomatous. The use of the kangri by the Kashmiri is akin to that of the chaufferette by poor old folk in France. Cruveilhier (1835) drew attention to chronic ulcers on the thighs of the old women, inmates of the Salpêtrière, and the formation of horns at their edges. Neve also mentions the formation of horns at the edges of kangri burns; he writes, "horny tumors are not rare, and sometimes at their base transition into epithelioma can be demonstrated."

It is admitted by all who have carefully studied squamous-celled cancer supervening on ulcers left by burns that the process is extremely slow, and this also is true of the closely allied condition known as soot cancer. In a remarkable instance of this disease under my own observation, the patient, a man aged fifty, in prosperous circumstances, consulted me in regard to a mass of enlarged inguinal lymph-nodes associated with an ulcer the size of a split pea on the scrotum; on looking closely at the scrotum I saw small spots which looked like soot marks, and he admitted, in reply to my question, that as a boy he had climbed and swept chimneys, but he had had no dealing with soot for thirty-five years. The disease was a typic example of soot cancer, and the man died in about twelve months. The relation of soot to this disease is difficult to explain.

Although chronic ulcers the result of burns are apt to become cancerous, Neve states, in regard to his extraordinary series of cases, that the burns more liable to this sinister change are those due to actual contact of the sooty pan with the skin. Such contact happens when the basket-work of the kangri is partially burnt.

This matter has received some elucidation from Legge's inquiry into what is known as pitch and tar cancer. This officer found a consensus of opinion among medical men and the pitch workers that those workmen who kept themselves clean and changed their clothing frequently did not suffer irritation of the skin, nor from the warts which are regarded by the men as precancerous conditions. It seems clear that the chronic dermatitis which precedes the cancer is caused by prolonged contact of the skin with the dust and dirt, which act as irritant particles. Many of the flat-topped, brownish-looking elevations on the skin of elderly persons who do not keep themselves clean are often little heaps of senile dirt.

The most puzzling form of skin cancer supervening on an ulcer left by a burn is that which occurs as a sequel to an *x*-ray burn. The alterations in the skin covered by the term *x*-ray dermatitis may affect not only those who receive the rays designedly for the cure of local disease, but also those who apply them. The earliest changes consist of an erythema, then small warts appear; cracks and ulcerated patches occur and refuse to heal. The ulcers and cracks are painful and, in a small proportion of cases, become malignant.

Rowntree, who has had opportunities of studying the pathology of several examples of *x*-ray cancer, states that the growth has all the

typic features of squamous-celled cancer, cell-nest formation being well marked. The precancerous stage—the stage of chronic dermatitis—is prolonged, and the transition to carcinoma is effected by slow and insensible gradations. He also states that since the introduction of *x*-ray treatment for lupoid ulcers the percentage of cases in which ulcers have become cancerous has materially increased.

Squamous-celled cancer occurring in the scars of burns, whether caused by heat or by *x*-rays, is usually of low malignancy, and the results of adequate operations, if undertaken early, are often satisfactory.

Cancer and Sepsis.—During the last decade physicians and surgeons have obtained clearer views of the relation of pathogenic micro-organisms to cancer. It is usually believed that carcinoma is a disease which, as a rule, quickly destroys its victim. As a matter of fact, cancer is often a chronic disease, and may take ten, fifteen, or even twenty years to destroy life. When cancer grows in situations where septic microbes have access to it, as in the mouth, colon, neck of the uterus, or on a cutaneous surface, they will cause decomposition, sloughing, and such septic infections as pneumonia, peritonitis, cystitis, pyelitis, and similar terminal infections. It is a noteworthy fact that cancer which runs the most rapid course occurs in positions most accessible to pathogenic micro-organisms, and the peculiar sallow complexion which used to be termed "cancerous cachexia," on which surgeons formerly placed so much reliance in the diagnosis of malignant disease, is, in reality, due to the absorption of the products, known as toxins, brewed by the micro-organisms which flourish in the cancerous tissues.

Surgeons turn this knowledge to practical account, especially in operating on the tongue or the neck of the uterus when cancerous, by ascertaining the nature of the septic organism which has invaded the tissues; then, by preparing and administering a suitable vaccine before operating, the risk of the patient dying from an intercurrent septic infection as a sequel to surgical intervention is diminished.

Trauma in Relation to Malignant Tumors.—Injury as an etiologic factor has been seriously advanced in the case of the breast, the testicle, and the bones, organs particularly exposed to injury.

The majority of women receive, in the course of their lives, an accidental blow upon the breast, and the frequency with which women attribute the cause of a cancerous tumor within the breast to an injury is largely due to the belief, deeply rooted in their minds, that such injuries are the common cause of cancer. About 10 per cent. of patients with mammary cancer can, and do, assign a specific injury as the starting-point.

Sarcomata are unusual tumors of the breast, and form about 10 per cent. of the malignant tumors of this organ. Sarcoma occurs at an earlier age than cancer, and women are most liable to this form of malignant disease between the twentieth and fortieth years of life, whereas cancer is most frequent between the thirty-fifth and fiftieth years. As with cancer, patients often attribute the tumor to an injury, especially to what may be called an "intensive injury."

It is a fact that surgeons see many patients afflicted with sarcoma and carcinoma who cannot recall any injury to the affected part, and, of the enormous number of contusions and injuries, only an infinitesimal proportion is followed by a malignant tumor. Small as is this number, the circumstances relating to these sequences are such as to lead surgeons to believe that a single "intensive" injury may occasionally induce the growth of a sarcomatous tumor.

The attitude of surgeons, as reflected in their writings, toward trauma, or physical insults, as an etiologic factor in the production of malignant tumors in the breast, justifies the following statement:

In regard to cancer (carcinoma), all surgeons of experience admit that there is a definite history of intensive mechanical injury in about 10 per cent. of the patients. They are very careful not to express a definite opinion as to the causal relationship of such injuries to the formation of cancer in the breast. There is a paucity of published statements from surgeons of great experience affirming trauma as a cause of mammary cancer.

In regard to sarcoma of the breast there is a definite opinion, held by experienced surgeons, to the effect that there are many carefully observed and thoroughly reported cases in which primary sarcoma of the breast has quickly supervened on a single intensive injury. The sarcomatous nature of such tumors has been ascertained by a microscopic examination at the hands of a competent pathologist, and their malignant nature has been confirmed by the early death of the individual. It is undeniable that a single intensive blow or knock on the breast may be occasionally followed by a sarcomatous tumor.

Trauma in an intensive form as a cause of sarcoma has been recognized for many years, especially in relation to bones.

Recently Coley has published a useful study of "Injury as a Causative Factor in Cancer," containing an analysis of 970 cases of sarcoma. In this series a definite history of trauma existed in 225. It is an important fact that awards are given in courts of law for malignant tumors which ensue within a reasonable time upon a definite gross injury.

Cancer of the lower lip is interesting in regard to trauma as a predisposing cause on account of the greater frequency of this disease in men than in women. In the Middlesex Hospital, London, during the years 1897–1907 (both years inclusive) 50 men with cancer of the lips were admitted into the surgical wards. In 2 the cancer began in the upper lip. No instance of this disease in the lip of a woman was seen in the hospital during that period. Observation teaches that cancer of the vulva in women is as common as cancer of the lower lip in men. In the decade 1898–1908 57 women were admitted into the Chelsea Hospital for Women and the Middlesex Hospital with cancer of the vulva. Of these women, 15 were widows, 34 married, and 8 spinsters. These observations suggest that trauma connected with coition and childbirth is a factor in producing changes in the epithelial investment of the vulva which favor the occurrence of cancer.

These facts also indicate that cancer of the vulva in women is as

common as cancer in the lower lip of men, and, like this disease in the lips and tongue, cancer of the vulva is preceded by the precancerous condition known as leukoplakia.

It is significant in relation to cancer of the vulva that trauma connected with the sexual act and its results should play the same part with the labia that the habit of smoking dirty, short clay pipes exercises on the lower lip.

Cancer of the neck of the uterus is almost exclusively confined to women who have been pregnant. Hence, injuries associated with coition and childbirth, but more especially the latter, are potent factors predisposing to this disease. It is disappointing to find that fecundity increases this liability.

Cancer of the Fallopian Tube.—In the chapter on Tumors, in Vol. I., p. 840, attention was drawn to the rarity of primary carcinoma of the ovary, and it was shown that many large tumors of the ovary, unilateral and bilateral, which exhibit the structure of cancer and were formerly regarded as arising primarily in the ovary are, in reality, secondary to cancer situated in some other organ, such as the breast, gall-bladder, or gastro-intestinal tract.

FIG. 17.—AN OVARIAN CYST WITH THE AMPULLA OF THE CORRESPONDING FALLOPIAN TUBE. (Bland-Sutton, Tumors, 5th ed.)

The tube was the seat of primary cancer; the cancerous cells escaping from the tube through its open ostium implanted themselves on the adjacent wall of the cyst.

The importance of these observations in clinical work was also pointed out. I have been able to implicate another organ in this matter, the Fallopian tube. Our knowledge of carcinoma of the tube dates from 1888, and, thanks to the industry of Doran, records of 100 cases of the disease are available for study. These records show that cancer of the Fallopian tube may be unilateral or bilateral; the frequency with which both tubes are attacked is far greater than usual among bilateral organs. I have been able to show that the clinical course of this disease is modified in a marked manner by the condition of the celomic or abdominal ostium of the tube. When the mouth of the tube remains open the cancerous cells escape into the pelvis and infect adjacent organs; this renders complete removal of the disease difficult and often impossible, and helps to explain the rapidity with which it recurs with disastrous effect to the patient.

In some instances the celomic ostium becomes occluded, as happens with infected tubes. This is fortunate for the patient, as it confines the cancerous material for a long time to the tubes, and, in the event of an operation, recurrence is long delayed. In some of the earlier cases the reporters were puzzled by the coexistence of a large cyst with the cancerous tube. I think the following observation will explain some of these things: On one occasion, when removing a large ovarian cyst from a woman of fifty-two years, I found the pelvic section of the tumor firmly adherent to the surrounding tissues. On examining the tumor after removal I found that the Fallopian tube connected with it had the ampulla stuffed with cancerous material. The ovarian cyst was of the ordinary multilocular type, but the parts in relation to the tube were infiltrated with cancer, and it could be seen easily that the thick mass on the cyst-wall was continuous with the cancerous material within the tube. The appearance presented by the parts was as if a stream of cancer particles had issued from the celomic mouth of the tube, and the cancerous cells had implanted themselves on the wall of the ovarian cyst. I have had another case in which both ovaries were cystic, and each was infected with cancer which arose in one of the Fallopian tubes.

The fact that cancerous cells retain their vitality in the peritoneal fluid, and are able to engraft themselves on the intestines, uterus, ovary, and parietal peritoneum, is an interesting fact.

Glendining has made some valuable observations in relation to cancer of the gastro-intestinal tract infecting the tubes. I removed two ovarian cysts infected with cancer; the primary focus of the disease was in the stomach. To the naked eye the Fallopian tube appeared normal, but, on microscopic examination, cancerous particles were found by Glendining free in its lumen; the subepithelial and plical folds were extensively infiltrated with cancer. From a careful consideration of this and some similar cases, Glendining came to the not unreasonable conclusion that the Fallopian tube was infected by cancerous cells swept into it through the celomic ostium, engrafting themselves on the mucous membrane and subsequently penetrating to the deeper tissues.

These facts have even a deeper significance. It has been mentioned already that cancer of the Fallopian tube is often bilateral, and it is a disease which gives bad results to operative interference. The observations mentioned above permit the inference that many cases of unilateral and bilateral cancer of the Fallopian tubes, supposed to arise primarily in them, are really examples of implanted cancer, and the primary focus may be situated in the gall-bladder, stomach, or some part of the colon.

In my early work on cancer I was often astonished to find the ovaries converted into irregular cancerous lumps, secondary to cancer of the breast, while the general peritoneal surface remained free. We know that cancerous cells are often destroyed in the peritoneal cavity. and of the thousands of cells which find their way into it only a small proportion succeed in engrafting themselves on the peritoneum and

grow into secondary knots. The cells which fall into the pelvis and lodge on the ovaries, lying on the floor of the rectovaginal fossa, flourish undisturbed because the ovary lacks a peritoneal covering. In some cases, where emigrant cancerous cells succeed in engrafting themselves on the peritoneum, it will be found, on examination, that they have had to struggle with the defensive power of the peritoneum, for the majority become surrounded by a fibrous cyst and in this way are often rendered inert.

Continued observation on malignant ovarian tumors convinces me that primary cancer of the ovary, using the term cancer to signify a malignant epithelial tumor, has not been demonstrated. Recently I removed a solid necrotic ovarian tumor from a woman aged sixty; the tumor was as big as her head. The cecum and ascending colon were somewhat distended, so I carefully examined the large bowel, expecting to find a primary growth in it, but failed to detect one. The microscopic characters of the tumor satisfied me that it was due to implanted cancer, secondary to a primary focus in the colon. Sixteen days after the operation the woman died from intestinal obstruction; at the postmortem examination, made by Dr. Spilsbury, a narrow contracting cancer was found in the sigmoid flexure of the colon and some secondary deposits in the liver. The cancerous tissue in the colon, the liver, and the ovary agreed histologically.

The interest of this case is clear. Although I was especially interested in the search for a primary colic growth during the operation, and examined the large bowel throughout (with gloved hands), the primary focus in the sigmoid flexure was so small that it was missed.

Primary Cancer of the Gall-bladder and Bile-ducts in Relation to Gall-stones.—(1) The gall-bladder. Cancer arises in any part of the mucous membrane of the gall-bladder, and, like this disease when it attacks the intestine, may project into its cavity as an exuberant fungating growth, or infiltrate its walls and spread directly into the subjacent hepatic tissue. The type of cells found in cancer of the gall-bladder is columnar or subcolumnar. When the walls of a cancerous gall-bladder are firmly compressed on the contained calculi the cells of the mucous membrane flatten out and become squamous cells, and cell-nests form.

The most important feature connected with primary cancer of the gall-bladder is its almost constant association with gall-stones. Careful investigations made on this point prove that in at least 95 per cent. of the cases of primary cancer of the gall-bladder gall-stones are present also.

Ten years ago cancer of the gall-bladder was considered a rare disease. The systematic examination of gall-bladders, removed in the course of operations for gall-stones, proves that it is a common affection.

Physiologic observation has taught us that the liver, in addition to its glycogenic function, is an organic filter, for it separates microorganisms from the blood conveyed to it by the portal vein and dis-

charges them with the bile. Micro-organisms eliminated in this way stimulate the epithelium of the bile-passages to unnatural growth.

Infection of epithelium causes it to multiply; this is exemplified in the gall-bladder. Its mucous membrane under normal conditions contains few glands, but, when it is chronically inflamed, mucous glands become abundant and of large size, and when a fistula forms between the gall-bladder and intestine its mucous membrane becomes thick and resembles that of the intestine. These mucous glands are important, for they are the chief sources of the calcium found in mixed biliary concretions. It is undeniable that gall-stones are a common complication of cancer of the gall-bladder, and many writers have maintained that they are the cause of the cancerous change. I have never accepted this opinion, preferring to believe that the pathologic conditions of the epithelium lining the gall-bladder, which cause it to produce cholesterin in abundance, increase its vulnerability to the microparasite of cancer.

The relations of gall-stones to cancer of the gall-bladder vary a great deal; in some instances the walls of the gall-bladder are greatly thickened, and the calculi are nested together in the center of the mass. In other cases the gall-bladder is filled with a semipultaceous mass of soft white growth, and the gall-stones are irregularly distributed through it. In other instances the walls of a cancerous gall-bladder are thick, tough, and firmly contracted on a set of gall-stones which completely fill it, yet the organ is free from adhesions and mobile; or, it may be tightly contracted on a solitary gall-stone, and the cancer so infiltrate the liver that there is no indication of the limit between the gall-bladder and the hepatic tissue.

Carcinoma of the Common and Hepatic Ducts.—Primary cancer may arise in any part of the extrahepatic ducts, including the ampulla; although it is a rare disease, there are many published records and specimens available for reference, and it is possible to furnish an account of its chief clinical and pathologic features.

Even excluding cancer arising in the ampulla, the common duct is the one most frequently affected, and in a fair proportion of cases the disease is situated at the junction of the hepatic cystic and common duct. The amount of growth is small, but it completely blocks the duct and leads to dilatation of the canals above the obstruction, which become distended with bile, and later, in the course of the case, this becomes replaced by mucous fluid which may be bile-stained. In many of the reported cases it is stated that there was evidence of more or less interstitial biliary fibrosis.

When cancer arises in the excretory ducts of the liver it is exceptional to find the disease associated with gall-stones.

Carcinoma of the Ampulla.—It is possible to distinguish between cancer arising in the common duct near its junction with the ampulla, and this disease starting in the epithelium lining the ampulla. Cancer in either situation needs to be distinguished from the same disease arising in the duodenal epithelium around the bile papilla (circumampullary carcinoma).

From a practical point of view, the distinction is not important, except in the particular that a cancer immediately above the ampulla would block the common bile-duct, but need not block the pancreatic duct, whereas a growth in the ampulla would obstruct the pancreatic duct as well as the common bile-duct.

It is a fact that primary growths of the ampulla are, as a rule, small, circumscribed, and have slight, if any, tendency to infiltrate surrounding structures. This is a matter of importance in connection with operative treatment, as it is possible for the surgeon to remove a cancerous ampulla with some hope of success.

Although cancer of the ampulla is very rare, Hartmann (1910), in reporting on 2 cases (1 of which was operated upon by Navarro, of

FIG. 18.—THE PYLORIC END OF THE STOMACH AND THE ADJACENT PORTION OF THE DUODENUM OF AN ELDERLY WOMAN. THE AMPULLA IS ENLARGED AND CANCEROUS.

Montevideo, and the other by Cunéo, of Paris), collected the records of 12 other cases of this rare disease which had been submitted to operation.

The **position of the cancer problem to-day** may be summarized thus:

In spite of an active research the cause of cancer remains undetected, but extensive observations indicate in no uncertain way that, when this disease occurs in skin or in mucous membrane easily obvious to examination, there is always some pre-existing lesion, such as a mole or a wart, or a chronic ulcer due to a burn, syphilis, or tubercle, in which the cancer arises. Almost every day convincing evidence accumulates, which shows that what is true of visible epithelial surfaces holds good for hidden epithelium. In the gland-tissue of the breast, in the mucous

membrane of the gullet, stomach, colon, rectum, gall-bladder, uterus, and bladder chronic lesions are common and many become the starting-point of cancer.

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CHAPTER XCVI.

THE USE OF ELECTRIC DESICCATION, FULGURATION AND THERMO-RADIOTHERAPY IN SURGERY.

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Since the advent of high-frequency electric currents various investigators have sought means to employ them as adjuncts to surgery, either by destructive action or biochemic effect. The literature upon this subject is chaotic, and the opinions of different surgeons of equal standing are at variance. This is probably explained by the fact that there has been no standardization of apparatus or methods, and, on account of the great variability of these currents as to strength and quality, hardly any two men who sought to compare results were employing exactly the same currents. To compare, then, the conclusions of men who specialize in other fields, and who have not the time to devote to the intricacies of the newer electric methods, would be misleading to those who seek exact data and unjust to the originators, who have developed an exact technic and are skilled in the use of their own instruments. Of the later electric methods which seem to have a tangible value are electric desiccation, fulguration, and thermo-radiotherapy.

DESICCATION.

Desiccation of living animal tissue is an effect produced by the proper application of an accurately measured electric current of high tension. For superficial destruction no bare electrode comes in direct contact with the tissue, but the current from one pole is concentrated and thrown from a metal point through an air space to the tissue in the form of sparks of great frequency, the other pole being grounded. For deeper destruction the bipolar method is used, the metal point is brought in contact with the tissue, and the large passive electrode is placed at some indifferent part of the body. A static machine of large output (2.5 to 3.5 ma.) is used to produce the initial current, which is stepped up by carefully measured capacity (0.00042 microfarads to each Leyden jar) and an accurately attuned resonator. The current from a coil or any magnetic device will not produce the desiccation effect on account of the interruptions in the primary, and as no discharge can be transmitted to the body until such interruption occurs, the current is delivered in a series of hot discharges which renders the thermic degree inconstant and the impact against the tissue painfully severe. A steady flow is necessary as is procured from the static machine, but

it must be of large output and subject to perfect control or it will fall short of the desiccation point. Desiccation should not be confused with fulguration or with high-frequency cauterization and coagulation. The first devitalizes by drying the tissue, the second shocks and produces hyperemia, but does not destroy, and the third is essentially the same as an ordinary cautery, though, perhaps, deeper in effect. It is possible with the same apparatus, by attaching a controlling device, to produce all thermic degrees, ranging from hyperemia to cauterization. The desiccation spark is not hot enough to carbonize, but only sufficient to cause rapid dehydration of the tissue, rupturing the cell capsule and converting the area treated into a dry mass. It has the power of penetrating into the tissue from a small fraction of an inch to an inch or even more, depending upon the frequency, distance of the electrode from the body, time of exposure, and density of the tissue. Not only can an area the size of a pin-point be desiccated without infringing upon the normal tissue, but a growth of considerable size may be destroyed with one application, though this is not always desirable. Desiccation de-

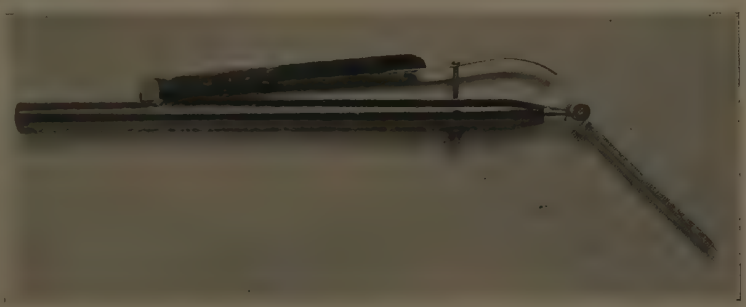


Fig. 19.—Instrument for Applying Desiccation or High-frequency Cauterization.

stroys tissue without opening blood- or lymph-channels, and will act as a styptic when there is oozing of blood. It sterilizes all tissue upon which it acts directly, as has been shown by careful experimentation with cultures taken before and after treatment. The desiccated tissue acts as a foreign body and a positive chemotaxis is promoted, which probably accounts for the rapid repair. The dry crust which forms acts as a natural dressing and separates in from three days to one week. Regeneration of skin or scar-tissue usually takes place underneath the crust. It is not very painful if applied with correct technic. In supersensitive individuals a local anesthetic is employed, either by topical application in the case of mucous membranes or ulcerated surfaces, or infiltration when the area is covered with skin, although the latter is never practised when there is a suspicion of malignancy, the ionic diffusion of cocain being preferable. In rare cases a general anesthetic is required.

Warts and Moles.—These are usually destroyed by one application. A dry crust at once forms, which separates and falls off in from three days to a week, depending upon the size of the area destroyed. Regenera-

tion of skin takes place underneath the crust. The slightly red area gradually fades to normal color. There is no contracture as from a burn, and the cosmetic effect cannot be improved upon by any other method. There is no doubt about the wisdom of removing these lesions for other than cosmetic reasons, as it is a well-recognized fact that sometimes cancer has its starting-point in an apparently innocent wart or mole.

Pigmentations, Vascular Nevi, Angeioma, and Tattoo-marks.—The results in these conditions have been very satisfactory. It is advisable to complete the destruction at one sitting unless the lesion is very large, when a number of applications may be necessary. When these lesions are superficial, new skin is formed; if deep, scar-tissue or a

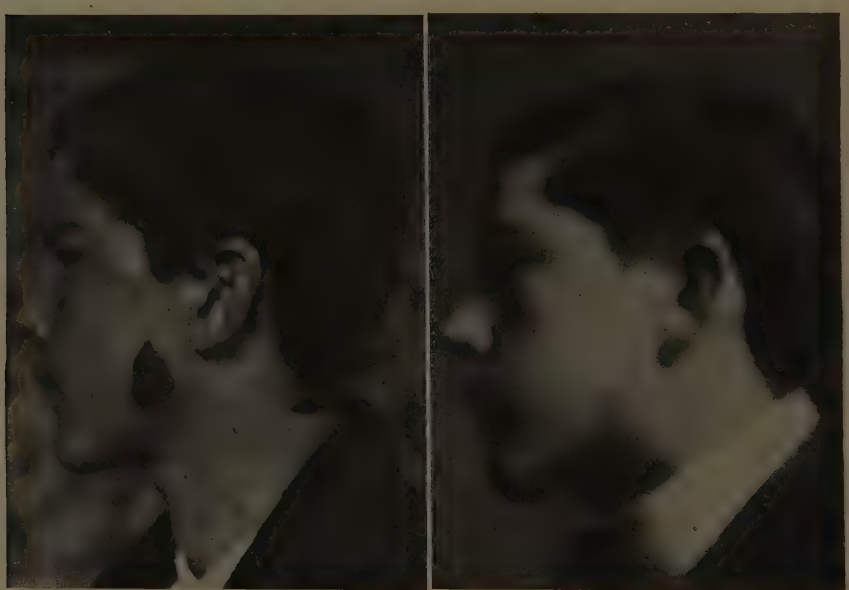


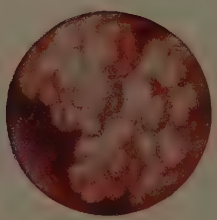
FIG. 20.—SHOWING THE RESULT OF DESICCATION TREATMENT OF AN ELEVATED PIGMENTED HAIRY MOLE.

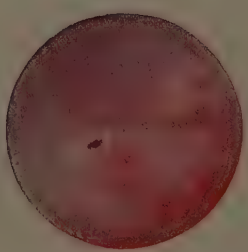
combination of skin and scar-tissue. The cosmetic effect depends upon the depth of destruction. Care should be taken to destroy the tissue perfectly evenly and not too deeply, as there may be cupping, irregularity of surface, and, if the spark is too hot, even a keloid. This may be avoided, however, by careful technic.

Chronic Varicose Ulcers.—The exuberant granulations are desiccated, after which ordinary methods, such as strapping and the silver nitrate stick, are employed. Several cases which had resisted ordinary methods of treatment healed quite rapidly after the granulations were desiccated.

Acne.—An attenuated spark of the same type as above is used, but it is not carried as far as actual destruction. The primary effect is local anemia, followed by an intense hyperemia. This method is

PLATE IV.





Papilloma of the Bladder Before and After Desiccation Treatment.
(Courtesy of Dr. B. A. Thomas.)

A Laryngeal Papilloma Treated by Desiccation which Has Not Recurred After One Year.

very efficient when used in conjunction with proper constitutional treatment.

Neoplasms in Some Hollow Viscera.—*Bladder.*—By using a catheterizing cystoscope an insulated wire may be passed through the instrument, the bladder being inflated with boric acid solution or sterile water, and tumors may be readily destroyed by desiccation (Plate IV.). When this current is passed through fluids the intensity should be slightly increased and the wire brought in direct contact with the growth. This work may, however, be done by high-frequency cauterization and coagulation, as has been reported by various writers during the past year.

Rectum.—Using a special air-inflation proctoscope, through which an insulated wire is passed, growths may be reached for a considerable distance up the rectum. By this method papillomata, ulcerations, cancer (for palliative treatment), and hemorrhoids, if for any reason operation is refused or contraindicated, may be treated.

Larynx.—In suitable cases tumors of the larynx may be destroyed by desiccation (Plate IV.). The laryngoscope or ordinary laryngeal mirror is employed to expose the interior of the larynx, and the current applied by means of an insulated wire curved like a laryngeal applicator.

The Eye.—Desiccation may be applied to the conjunctiva in trachoma, dry granular conjunctivitis, epithelioma, and to the cornea for granulating ulcerations and pterygium. There is no danger in working near the eye, as the control of the desiccation current is absolute.

Cancer.—Desiccation should be employed alone only in superficial epitheliomata. The destruction should be complete and carried beyond the diseased area. Blood- and lymph-channels are sealed, which would seem to render metastasis less likely. The results have been very satisfactory. In advanced epithelioma where there is deep involvement of tissue, but without glandular involvement, curetment or excision should be practised first, followed immediately by desiccation. It is employed only in such cases when the wound is left open. When it is necessary to close the incision, as in cancer of the breast or the cervical glands, desiccation treatment is not to be recommended, because the débris could not find exit, even with drainage.

In cancer of the cervix, if inoperable, desiccation as a palliative measure probably has an advantage over the curet and cautery. It may be done without a general anesthetic, it destroys as effectively, sterilizes, deodorizes, and acts as a styptic.

In cancer of the mucous membranes, such as the tongue, the buccal surfaces, or the lip, unless seen early, desiccation should not be employed alone, because the glands are usually involved, even though they are not palpable, for the diseased tissue must be accessible to expect a good result with desiccation. The correct surgical procedure, then, is complete extirpation of the initial lesion and thorough excision of the glands likely to be involved, followed by desiccation if the wound is left open, or by fulguration if sutured, and then by the *x*-ray. In cancer that

is absolutely inoperable the *x*-ray should be applied. There is evidence to show that seemingly inoperable cancer may sometimes be made operable by the intelligent use of the *x*-ray.

Among other conditions in which desiccation may be considered are: Hypertrophic tonsils, where there is contraindication to operation, minor nasal growths, xanthoma, granulations on the tympanum, early Paget's disease, lupus, *x*-ray and senile keratoses, chancroids, granulations in the urethra, erosions of the cervix, urethral caruncle, condyloma, keloid, certain forms of eczema, and parasitic skin diseases.

FULGURATION.

Fulguration is a method advocated and devised by De Keating-Hart, of Paris, to be used in combination with operative measures, especially in the treatment of cancer. The growth, with all adjacent glands, is

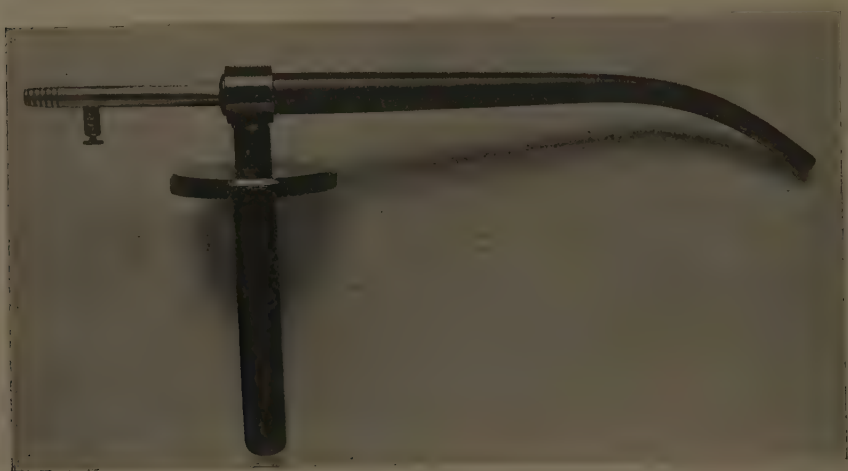


FIG. 21.—DE KEATING-HART'S FULGURATION APPLICATOR.

first thoroughly excised, and the wound is at once treated with a bombardment of high-frequency sparks from 4 to 8 inches long. The initial current is obtained from an induction coil and stepped up by a capacity, such as Leyden jars and an Oudin resonator. The fulguration applicator consists of a curved, hollow, hard-rubber tube 14 inches long, the greatest diameter of which is $1\frac{1}{2}$ inches, and tapering so that the end from which the sparks are delivered is $\frac{1}{4}$ inch in diameter. A rubber handle 10 inches long is attached to the tube nearly at right angles, to protect the hand from sparks. A hollow graduated metal tube 8 inches long is inserted into the proximal end of the hollow rubber tube, a stiff wire taking up the rest of the distance to the distal end. Filtered and cooled sterilized and compressed air is passed through the hollow metal tube while the sparks are passing to prevent burning of the rubber, and to blow the blood away from the field, so that the sparks may strike the tissue direct. The metal tube may be withdrawn so that any

length of spark desired may be obtained. The time of exposure depends upon the size of the area to be treated and the character of the condition. Roughly speaking, an average case of cancer of the breast requires about ten minutes to fulgurate it thoroughly. The physiologic action is not positively known, but is probably due to an alteration of nutrition of the tissues, which is said to render the soil less fertile for the proliferation of cancer cells. Fulguration as devised by De Keating-Hart is never used for destruction of cancer or of any tissue. He has shown freedom from recurrence ranging from one to five years, even in

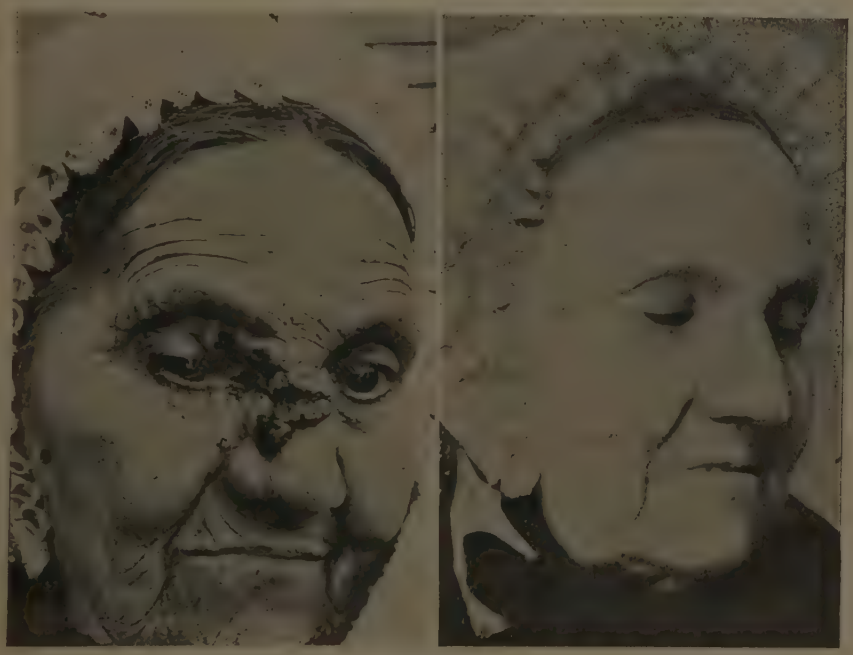


FIG. 22.—DE KEATING-HART'S CASE OF EPITHELIOMA CURETED AND FULGURATED. Well five years after treatment.

advanced cases of cancer. This method is now being tested in Philadelphia and New York, but no positive final conclusions can yet be drawn.

THERMO-RADIOTHERAPY.

Thermo-radiotherapy is a term applied to a new method of applying the *x*-rays, the aim being to increase the efficiency of the rays. De Keating-Hart claims that the radio-sensitiveness of tissue is in direct proportion to its temperature, the warmer the part the more intense is the action of the rays, and *vice versâ*. To increase the temperature beneath the skin surface he uses a method known as thermo-penetration, or diathermy, a high-frequency process which causes heat to reach deeply into the tissue. To counteract dermatitis, in addition to the usual leather or aluminum filter, cracked ice between two layers of

gauze is applied over the skin, or the surface is moistened with water and fanned to promote evaporation, thereby cooling it. He claims that the thermo-penetration increases the deep action of the rays, and chilling the skin will prevent dermatitis, even though the treatments are frequent and the dose massive. It is a well-known fact that Röntgenologists are hampered in treating inoperable or postoperative malignant conditions, because they dare not apply massive doses frequently on account of the danger of a severe burn, which shows little tendency to heal, and the long interval between treatments allows the cancer to gain headway. Indeed, there is evidence to show that malignant growths have been stimulated and have grown rapidly after the application of the ray. The probable reason for this is because a stimulating rather than a killing dose was given. The merit of Hart's method is that killing doses may be given without burning the skin, and the efficiency increased by deep heating of the tissue. Hart has presented evidence to show that probably his premise is correct. The method is also being tested in Philadelphia and New York, and the work thus far seems to verify Hart's contention. The method, of course, does not apply to skin diseases where a superficial stimulating effect is desired, but only in deep lesions for which the *x*-ray is applicable. Thermo-radiotherapy may be employed in malignant conditions following fulguration or desiccation to increase the efficiency of these methods.

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NOTE ON THE TREATMENT OF MOUSE CANCER BY EOSIN AND SELENIUM.

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A. von Wassermann, von Hausemann, Fr. Keyser, and M. Wassermann,[1] basing their work on that of former experimenters, especially that of Ehrlich, have experimented on inoculated mouse cancer. They sought some chemical which would prevent the rapid growth of the tumor-cells or even destroy them without attacking cells of the normal tissues.

Salts of selenium and tellurium were found to be reduced and the metals deposited in the mouse tumors, followed by softening and destruction of the tumor-cells—the detritus being sterile. Finally, after testing more than 200 varied chemical combinations, they found that a compound of eosin and selenium when injected into the blood-stream was deposited in the cancer-cells. After a few injections softening began, and after the seventh and eighth the tumors disappeared. A number of these mice which were free from recurrence " for months " were shown at the meeting of the Berlin Medical Society.

In a number of cases, however, the injection produced a severe reaction and killed the mice. In case also the tumors were large, death followed apparently from the absorption of the toxins produced by the destruction of the cancer-cells. In the mice that thus died, however, no trace of the tumor could be discovered. In some cases the softened contents of the tumor ulcerated through the skin, were discharged externally, and a secondary infection would then kill the mice. In case any portion of the tumor remained undestroyed, recurrence took place in from eight to fourteen days, and further injections were fruitless.

Two *spontaneous* cases of mouse cancer were treated: one died after apparent cure, the other was shown to the Society, and was free from recurrence after some months.

Microscopic examination showed that the selenium was deposited as very small black grains directly in the cell-nucleus, which was broken up into small drops and fragments. No infiltration of leukocytes occurred unless after ulceration and secondary infection. The spleen became enlarged, but never to such an extent as in infective processes. No metastasis occurred, even when considerable cell detritus was recognized in the spleen, and also to a less extent in the liver, the apparent reason being that there were no intact living cells to be seen. No detritus was ever found in the lungs. The final destruction of the cell detritus seemed to occur principally in the spleen and to a less extent in the liver. In a single case a nephritis was found, but in this case an inferior preparation had been employed.

Hausemann, who did the microscopic work, does not believe that the so-called mouse cancer is the same as human cancer, though other observers believe that it is.

[1] Berlin. klin. Woch., Jan. 1, 1912, p. 4.

Evidently these chemiotherapeutic researches are of the greatest importance, as they show that in certain mouse tumors, whatever their nature may be, a remedy introduced by way of the blood-current has a selective affinity for the nuclei of the cells of such tumors, destroys the nuclei, and so arrests the growth of the tumor-cells and produces a detritus which is capable of being absorbed, thus curing the mice. The danger of the remedy is considerable, and in the case of large tumors the remedy may be indirectly lethal by absorption of the resulting toxins.

The whole matter is so absolutely in the experimental stage, even in the case of mouse tumors, that we should heed the warnings of the authors that we may not yet call the eosin-selenium compound a " cancer cure " even in mice.

Until much more has been done in investigating the character of the mouse tumors and the action of this eosin-selenium compound; or some other similar remedy of the many which modern synthetic chemistry may put at our disposal has been produced; and until a safe as well as efficient remedy has been found for such tumors in mice, no thought should be entertained of applying the remedy in case of malignant growths in human beings. No one should lead a patient suffering from such a growth even to hope, much less believe, that he may be cured by the use of this or any other similar remedy, only to find his hopes blasted or even his life imperiled or lost by the rash use of a new, apparently efficient, but dangerous remedy.

That these researches on animals *may* point in the right direction and ultimately may lead to the discovery of a cure for this dreaded malady is earnestly hoped for, and is not impossible.

These researches have aroused the intense interest of the whole profession, and especially of pathologists and surgeons. Our fervent hope is that they may ultimately banish the knife—the only present reliable remedy for cancer. In so doing one of the most important sources of income of surgeons will be abolished. The altruism of the profession could not be better illustrated than by these welcome investigations in cancer and in the equally splendid campaign against tuberculosis.[1]

[1] Besides the article referred to above, see the Deutsch. med. Woch., Dec. 21, 1911, xxxvii., Nr. 2, p. 2389; Jour. Amer. Med. Assoc., Editorial, Jan. 13, 1912, p. 120; their Berlin letter, p. 127, and the New York Med. Jour., Feb. 3, 1912.

Since the above was put in type the following additional references have come to my notice: Neuberg, Caspari, and Löhe, "Weiteres über Heilversuche an geschwulstkranken Tieren mittelst tumoraffiner Substanzen," Berlin. klin. Woch., July 22, 1912, and an excellent editorial in the Brit. Med. Jour. for Aug. 24, 1912, p. 448, giving a rather full statement of their work. They elaborated tumor-selective compounds from nearly a dozen metal bases. Those from "copper, tin, platinum, and especially cobalt and silver, were found to give the best results."

CHAPTER XCVII.

SURGICAL SHOCK.[1]

By George W. Crile, M. D.,

Cleveland.

From the data of experimental research and from clinical observations I have on previous occasions proposed a hypothesis for the explanation of shock. This hypothesis may be appropriately designated the exhaustion hypothesis. This hypothesis assumes that animals that are especially capable of being shocked are those whose self-preservation is dependent upon special forms of motor activity; that the motor activity is excited by adequate stimuli of their various nerve receptors, both contact receptors, through nerve-tissue directly, and distance receptors, through the special senses; that the stimuli transmitted through the distance receptors are as potent as those through the contact receptors. This hypothesis further assumes that the environment of the past (phylogeny) through adaptation predetermines the influence of the environment of the present; that certain reactions, such as certain forms of tickling, and the intensity of certain environmental contacts are in man now obsolete, but may be understood by assuming a harsher environment of our progenitors. This hypothesis assumes that whatever may have been the origin of the motor mechanism and its adaptive response on stimulation, there is in each individual at a given time a limited amount of potential energy; that motor activity following each adequate stimulus diminishes the amount of this potential energy; that in any animal a sufficient number and intensity of the stimuli leads inevitably to exhaustion or death; that when the motor activity takes the form of obvious work performed, such as running, the phenomena expressing the depletion of the vital force is termed *physical exhaustion;* and that when the expenditure of the vital force is due to stimuli which lead to no obvious work performed, especially if the stimuli are strong and the expenditure of energy rapid, it is designated as *shock.*

In support of this hypothesis I shall present evidence tending to show that the phenomena of exhaustion from physical exertion closely resemble shock; that shock may be acute or chronic; that in shock every organ of the body exhibits certain evidences of pathologic physiology; that recovery from shock often requires a long time; that fear and trauma have a common phylogenetic origin and are akin; and that in the brain-cells there is found a physical basis of shock.

[1] Supplementary to Chapter XXII., Vol. I., p. 922.

Beginning with the last point—viz., What evidence is there of an anatomic basis in the brain-cells for shock?—J. B. Austin, in my laboratory in the course of three years of continuous work, has made histologic studies of the various parts of 312 individual human and animal brains. Among these, 48 were normal and 264 had been modified by disease or injury. In these studies Austin studied and counted over 10,000 individual cells. This material was studied and described by him by number without knowledge of the histories. All of the material is preserved for any one's observation. The physiologic work was done by Sloan, the data collected by Hitchings, the histologic study by Austin, the physical chemistry by Menten, and the summary and deductions by myself.

These studies included acute and chronic emotional excitation of rabbits; acute physical injury of dogs under inhalation anesthesia; emotional stimulation in a dog; dog fights; foxes chased and killed by hounds; normal foxes; acute pyogenic infections in dogs; dogs given strychnin, alcohol, ether, curare, iodoform, thyroid extract, and adrenalin; acute trauma of the paralyzed territory of "spinal dogs"; dogs with crossed circulations by anastomosis of their carotid arteries; dogs under curare; acute trauma in dogs during overtransfusion to prevent the factor of anemia; dogs in acute hemorrhage; dogs killed and then resuscitated at various intervals; dogs and rabbits with adrenalectomy; active ventilation of the lungs for an hour or more of dogs under curare; prolonged direct electric stimulation of the brain of dogs. The human material included the brains of a workman killed almost instantly by falling from a high building; of a young man killed by stabbing; a man shot through the heart; a newborn babe and an old man; cases of Graves' disease; of pneumonia; of typhoid fever; of delirium tremens; of cancer cachexia with infection; of pyogenic infections, and of eclampsia.

These brain-cell studies were made with reference to the following points: the size of the cells; the amount and the physical condition of the component parts of the cell; the number of cells in a field, and the intervening granular cells. From this material the following statements may be made:

All normal cells fell into a class distinct from those of all the pathologic animals by closely resembling each other. As to the brains of the animals modified by disease, by drugs, or by stimulation, many variations were noted. First, as to the diseased animals, in no instance of acute pyogenic infection was there an increase of the Nissl substance, but in every instance there was a decrease, and there were marked alterations in their morphology; in strychnin-poisoning there was at first a marked increase in the Nissl substance, but the animals kept alive for several hours showed a marked decrease of this substance and marked physical changes. Ether, chloroform, nitrous oxid, and morphin produced but slight changes. So, too, the adrenalin brain showed little if any change. Iodoform produced a marked decrease in the Nissl substance and marked physical changes. Alcohol in small doses and immediately after large doses showed scattered increase of Nissl substance; while lethal doses

showed diminished Nissl substance and morphologic deterioration. In man, in every case of death from disease, whether from cancer, typhoid, acute infection, Graves' disease, eclampsia, or delirium tremens, there was found a diminution in the Nissl substance and marked morphologic alteration of the cells, but in the human beings in good health killed rather suddenly the physical condition and the Nissl substance approached the normal. Turning again to the experiments, the brains of dogs traumatized under inhalation anesthesia showed a variation in the physical changes as follows: a momentary trauma caused an increase in the Nissl substance, but when the trauma was repeated over varying periods causing different degrees of shock the physical changes in the brain-cells varied according to the depth of shock as indicated by the blood-pressure.

Under nitrous oxid anesthesia (an oxyhemia anesthesia or, at least, a condition in which there is a great diminution in the oxygen) the physiologic changes and the brain-cell changes following an equal trauma were approximately one-third that after ether; traumatized animals whose blood-pressures were maintained by direct transfusion of blood, thereby eliminating the factor of anemia, still showed physical changes in their brain-cells; transfused animals similarly anesthetized and transfused, but not traumatized, showed no change; animals killed and then resuscitated showed brain-cell changes roughly proportional to the duration of suspended animation and the time that elapsed before definite death.

Animals deeply anemic from acute hemorrhage showed at first but slight changes, but as time elapsed these changes increased. Animals given excessive doses of thyroid extract over several weeks, and which showed symptoms of hyperthyroidism, presented an increase of Nissl substance. Animals traumatized under morphin and curare showed typical brain-cell changes, but no amount of trauma in the paralyzed territory of dogs whose spinal cord had been divided several months previously caused any change in the brain-cells; in the pair of dogs whose circulations were crossed and whose blood-pressures were maintained by transfusion the brains of the traumatized dogs showed the typical changes, while the brain-cells of their untraumatized fellows showed no brain-cell changes. Dogs whose lungs were actively "ventilated" for an hour or more showed no brain-cell changes. Direct trauma of the hemosphere, howevere severe, caused no brain-cell change in the opposite side.

In the rabbit subjected to acute and to chronic fear the brain-cell changes were as follows: In acute fear, if killed immediately, the Nissl substance was increased; if killed from four to six hours later there was found marked deterioration of the brain-cells. In chronic fear, whether killed after the last séance or after a quiescent period of twelve hours, deterioration of the brain-cells was seen. In the foxes chased and killed by hounds deterioration was seen. The brain-cells of the dogs in a severe fight showed deterioration, and the cells of the dog under sexual excitation showed an increase in the Nissl substance.

These findings may be generalized as follows: Whether as a result of disease, of injury, of drugs, or of emotional stimulation, the physical state of the brain-cells corresponded closely with the state of vitality; not only the state of vitality as a general term, but also the state of such functions as cerebration, digestion, muscular power, respiration, circulation, disturbance of metabolism, of excretion; in short, of most of the bodily functions. Then, too, in both animals and in man the physical conditions of the brain-cells apparently was a good index of the extent of surgical operation that could probably have been endured. In old age, for example, the total number of cells are much diminished; so, too, is the vitality and the ability to endure surgical operations, physical exertion, emotional stimulation, or disease decreased.

Direct electric stimulation of the brain over considerable time caused no physical changes in the brain-cells. This compares well with the observations in animals and man, viz., if heavy shocks are not fatal, no special exhaustion follows; indeed, it would seem that electricity is not an adequate stimulus to produce shock, but rather merely runs over the nerve-paths *as a force akin to nerve force;* hence, it may not cause a conversion of the chemical compounds of the nerve-cells into potential force which, in turn, produces motion. Electricity seems to be an inadequate means of studying shock phenomena.

The foregoing tends to show that there is in the brain-cells the labile compounds capable on adequate stimulus of converting their potential energy into kinetic.

This substance in part or entirely is selected by the Nissl stain, and its quantitative variation corresponds to vital power. As Sherrington has said, environment drives the brain and the brain drives the various organs of the body. The principal changes in the composition of the blood, in the respiration, in the circulation, in the functions of organs, whether increased or suspended in physical exertion, as a result of physical injury and emotional stimulation, are but a part of the adaptive reactions through the influence of the excited brain. These phenomena though important, seem to us to be secondary, while the changes in the brain are the primary lesion in shock.

On this conception we can understand the disturbance of the digestive and procreative functions; increased adrenalin output, glycosuria, increased thyroid, cardiac, respiratory, and metabolic activity resulting from worry, which is only intermittent fear.

This condition is chronic shock. What do we find in acute shock and acute fear? A stimulative integration of all of the organs that can add to the motor efficiency of the individual, and an inhibition of the organs that can play no rôle in the motor efficiency.

Among the well-known results that may follow intense worry are the following: mental inefficiency, loss of physical strength, loss of appetite, indigestion, increased perspiration, increased heart-rate, rise in blood-pressure, cardiovascular disease, glycosuria, neurasthenia, Graves' disease, and loss of weight. These may be secondary phenomena of repeated emotional stimuli or chronic shock.

We have stated that in chronic shock this group of secondary phenomena *may* express themselves in a variety of forms, and that they are the same as in acute shock. We will now offer a direct clinical test in a large number of cases, a test that is unequivocal. If our hypothesis is correct, *i. e.*, that shock is merely an overstimulation of the whole motor mechanism—a mechanism that includes most of the organs of the body—and if the adequate stimuli are either emotional or physical, then, if a given patient be kept free from any emotional excitations by special management and by narcotics, or if the patient is not permitted to know that the operation is to be performed at a specified time, and if such patient be anesthetized in such manner that no adaptive response is excited by such an anesthetic as the pleasant nitrous oxid, and if the field of operation be so completely blocked by local anesthesia that no traumatic impulse reaches the brain, and if in closing the wound another local anesthetic that will block nerve impulses for, say, for twenty-four hours, thus preventing the after-pains, such a patient will then have been operated upon in such a manner that the motor mechanism has received no adequate stimulus. Such is in the state designated anoci-association (Vol. VI., p. 150). Hence, there should be no surgical shock, no interference with digestion, no nervous impairment afterward, *i. e.*, there should be no change in the circulation, the respiration, the digestive function, nor the mentality of the patient. This is just what follows a perfect carrying out of this principle. I have attempted to carry out this technic in many patients and have found that regardless of the weakened condition of the patient before the operation, and regardless of the magnitude of the operation, just in proportion to the completeness of the technic do we secure immunity from shock in the broad sense in which that word is used in this chapter.

Recapitulation.—Man is essentially a motor mechanism of many parts which are integrated by the nervous system. This neuromotor mechanism is driven by the stimuli of environment. Whenever excessively driven, exhaustion is produced. The evidence of the active response to the stimuli and the consequent exhaustion is seen in the altered function of many organs and in morphologic changes in the brain-cells.

That these changes are caused primarily by adequate stimulation and not by changes in the blood-content or by secretions of glands is shown by the following: emotional stimulation alone or any combination may cause identical shock; under curare and even artificial respiration shock may be produced, but no amount of trauma of the distal territory of a " spinal dog " can cause shock; when the circulation of two dogs is crossed, and only one dog is traumatized, the traumatized dog is shocked; the untraumatized dog is not shocked; finally, in a large number of shock-producing operations on patients whose brains received neither emotional nor traumatic stimuli—hence the motor mechanism was not driven at all—showed no shock whatever. This held in both the laboratory and the clinic, and regardless of the gravity of the risk or the magnitude of the operation.

CHAPTER XCVIII.

ANOCI-ASSOCIATION.

By George W. Crile, M. D.,

Cleveland.

Man is primarily a motor being, constructed by the process of adaptation to environment in the struggle for existence. There are two principal parts of this motor mechanism: first, the part which perceives his relations to the material world (environment); second, the motor mechanism itself, which is driven by environment. The principal receptor mechanisms are those which perceive changes in the waves of light, the waves of air, and which perceive changes in chemical qualities, in temperature, and in various grades of physical contact. The adequate stimulation of these mechanisms produces seeing, hearing, taste, smell, touch, pain, heat and cold sensations, and tickling sensations. It is through associative memory that this type or that type of response of the individual as a whole is made. A given stimulus, which causes an association, may benefit the individual (*bene*-association), or it may harm the individual (*noci*-association).

Now a surgical operation performed upon a patient whose receptor mechanisms are not suspended by anesthetics causes an adequate stimulus of one or more of the receptors, hence, causes a stimulation of the motor mechanism as a whole, that is, of the individual as a whole. If the activity of the various receptor mechanisms is blocked or suspended, then the operation may be performed without stimulating the motor mechanism at all; that is to say, there will be no *noci*-association. That state of the patient can be described only by coining a new word, namely, *Anoci-association.*

Since this is a new theme and a new principle, a statement of the principal evidence on which it rests follows:

When a barefoot boy steps on a sharp stone there is an immediate discharge of nervous energy in his effort to escape from the wounding stone. This is not a voluntary act. It is not due to his own personal experience (namely, his ontogeny), but is due to the experience of his progenitors during the vast periods of time required for the evolution of the species to which he belongs—*i. e.*, his phylogeny. The wounding stone made an impression upon the nerve receptors in the foot similar to the innumerable injuries which gave origin to this nerve mechanism itself during the boy's vast phylogenetic or ancestral experience. The stone supplies the phylogenetic association, and the appropriate discharge of nervous energy automatically follows. If the sole of the

foot is repeatedly bruised or crushed by the stone, shock may be produced. If the stone be only lightly applied, then there is also a discharge of nervous energy from the sensation of tickling. The body has had implanted within it in a similar manner other mechanism of ancestral or phylogenetic origin, whose purpose is the discharge of nervous energy for the good of the individual.

The word anesthesia—*meaning without feeling*—describes accurately the effect of ether in anesthetic dosage. Although no pain is felt in operations under ether anesthesia, the *nerve impulses set up* by a surgical operation still reach the brain. We know that not every portion of the brain is fully anesthetized, since surgical anesthesia does not kill. The question then is, What effect has trauma under surgical anesthesia upon the part of the brain *that remains awake?* If in surgical anesthesia the traumatic impulses cause an excitation of those wide-awake cells, are the remainder of the cells of the brain, despite anesthesia, influenced in any way? If influenced they are prevented by the anesthesia from expressing the same in conscious perception or in muscular action. Whether the *anesthetized* cells are influenced or not must be determined by noting the physiologic function after anesthesia has worn off, and in animals by an examination of the brain-cells as well. It has long been known that the vasomotor, the cardiac, and the respiratory centers discharge energy in response to traumatic stimuli applied to various sensitive regions of the body during surgical anesthesia. If the trauma is sufficient, exhaustion of the entire brain is observed after the effect of the anesthetic has worn off, that is to say, despite the complete paralysis of voluntary motion and the loss of consciousness due to ether, the traumatic impulses that are known to reach the *awake centers* in the medulla also reach and influence every other part of the brain. As to whether or not the consequent functional depression and the morphologic alterations seen in the brain cells may be due to the low blood-pressure which follows excessive trauma is answered by the following experiments—viz., the circulation of animals was first rendered static by overtransfusion, and was controlled by a continuous blood-pressure record on a drum; the factor of anemia was wholly excluded during the application of the trauma and during the removal of a specimen of brain tissue for histologic study. In every such instance morphologic changes in the cells of all parts of the brain were found, but it required more trauma to produce equal morphologic changes in animals protected against low blood-pressure than in animals whose blood-pressure gradually declined in the course of the experiment.

In the cortex and in the cerebellum the changes in the brain cells were in every instance more marked than in the medulla. There is also a strong *negative* evidence that traumatic impulses are not excluded by ether anesthesia from the part of the brain that is apparently asleep. This evidence is as follows: If the factor of fear be excluded, and if, in addition, the traumatic impulses are prevented from reaching the brain by cocain blocking, then, despite the intensity or the duration of the trauma within the zone so blocked, there follows no exhaustion after the

effect of the anesthetic disappears, and no morphologic changes are noted in the brain-cells. A still further negative evidence that inhalation anesthesia offers little or no protection to the brain-cells from trauma is derived from the following experiment: A dog whose spinal cord had been divided at the level of the first dorsal segment, and then kept in good condition for two months, showed a recovery of the spinal reflexes, such as the scratch reflex, etc. This animal is known as a "spinal" dog. Now, in this animal the abdomen and hind extremities have no direct nerve connection with the brain. In such a dog a continuous severe trauma of the abdominal viscera and of the hind extremities, lasting four hours, caused not the slightest change in either the circulation or respiration, and no microscopic alteration of the brain-cells. Judging from a large number of experiments on *normal* dogs under ether, such an amount of trauma would have caused not only a complete physiologic exhaustion of the brain, but also morphologic alteration of all the brain-cells and physical destruction of many. We must, therefore, conclude that although ether anesthesia produces unconsciousness, it *apparently protects none of the brain-cells* against exhaustion from the trauma of surgical operations. Ether is, so to speak, but a veneer. Under nitrous oxid anesthesia there is approximately only one-fourth the exhaustion after equal trauma as under ether; either nitrous oxid protects or ether predisposes to exhaustion under trauma. With this as a point of departure, we will inquire into the cause of this exhaustion of the brain-cells.

ON THE CAUSE OF THE EXHAUSTION OF THE BRAIN-CELLS FROM TRAUMA OF VARIOUS PARTS OF THE BODY UNDER INHALATION ANESTHESIA.

Numerous experiments on animals upon the effect of ether anesthesia *per se* (*i. e.*, ether anesthesia without trauma) showed neither characteristic physiologic exhaustion after the anesthesia had worn off, nor were there seen the characteristic changes in the brain-cells. Turning to trauma, in a study of the behavior of individuals as a whole under deep and under light anesthesia, we at once found the cue to the discharge of energy, the consequent physiologic exhaustion and the morphologic changes in the brain-cells.

If, in the course of abdominal operations, rough manipulation of a parietal peritoneum is made, there is frequently observed a marked increase in the respiratory rate and an increase in the expiratory forces, even to the extent of an audible expiratory groan. Under light ether anesthesia severe manipulation of the peritoneum often causes such vigorous contractions of the abdominal muscles that the operator is greatly hindered in his work.

Among the unconscious responses to trauma under ether anesthesia are purposeless moving, withdrawing of the injured part, and, if the anesthesia is sufficiently light and the trauma sufficiently strong, there may be an effort directed toward escape from the injury. In injury under ether anesthesia every grade of response may be seen, from the

PLATE V.

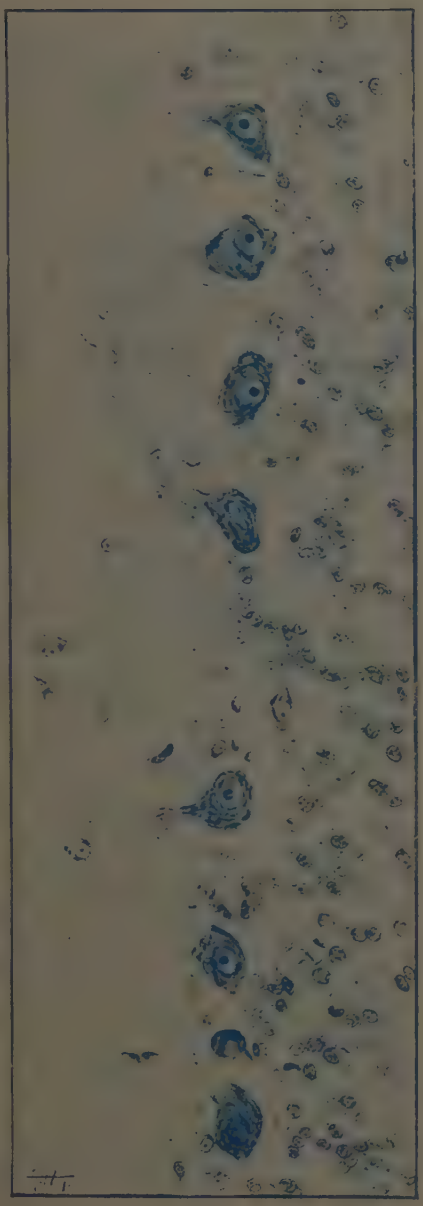

Fig. 1.—Cerebellum from a Normal Dog.

Differential Purkinje cell counts from ten normal dogs gave averages as follows: Active cells, 71.2 per cent.; fatigued cells, 28.1 per cent.; exhausted cells, 0.7 per cent. Note that the chromatin in the Purkinje cells shown in the illustration is not only plentiful, but also in large and distinct granules.

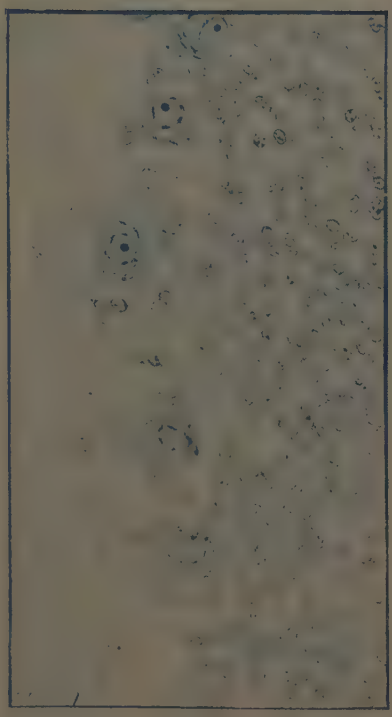

Fig. 2.—Cerebellum from a Dog Reduced to Profound Surgical Shock Under Ether Anesthesia.

Differential Purkinje cell counts from five experiments in which dogs were reduced to profound surgical shock while under ether and killed before recovering from the anesthetic gave averages as follows: Active cells, 51.3 per cent.; fatigued cells, 37.3 per cent.; exhausted cells, 11.4 per cent. Note the faded condition of the cells when compared with the section of cerebellum from a normal dog. This is due to loss of intranuclear as well as intracellular chromatin. Compare the 11.4 per cent. of exhausted cells (that is, cells which are so injured as in all probability to be incapable of restoration to normal) due to shock with the 0.7 per cent. of exhausted cells found in the normal dog.

slightest change in the respiration or in the blood-pressure to a vigorous defensive struggle. As to the purpose of these subconscious movements in response to injury there can be no doubt, *they are efforts at escape from the injury.*

Can anyone picture the actual result of a formidable abdominal operation, extending over a period of half an hour or more in an unanesthetized human patient, if extensive adhesions are broken up, or if a large tumor is dislodged from its bed? In such a case would not the nervous system discharge its energy to the utmost in efforts to escape from the injury, and would the patient not suffer complete exhaustion? If the traumata under inhalation anesthesia be sufficiently strong and repeated in sufficient numbers, the brain-cells will finally be deprived of their dischargeable nervous energy and become exhausted, just as exhaustion follows a strenuous and too prolonged muscular exertion; for example, such as is seen in endurance contests. Whether the nerve energy of the brain is discharged by injury under anesthesia or whether by ordinary muscular exertion, identical morphologic changes are seen in the nerve-cells. In shock from injury, in exhaustion from overwork (Hodge and Dolley), and in exhaustion from pure fear, the general functional weakness is similar—in each, a certain length of time is required to effect recovery, and in each there are morphologic changes in the brain-cells. It is quite clear that in each of these cases the altered function and form of the brain-cells are due to an *excessive discharge of nervous energy.* This brings us to the next question, viz., What determines the discharge of energy from trauma, with or without inhalation anesthesia? We postulate that the discharge of nervous energy is determined by emotional and traumatic stimuli; that is, such discharge of nervous energy as would be of interest to surgeons. We have already spoken of trauma. We will now consider the emotions.

THE DISTRIBUTION OF THE EMOTIONS IN NATURE.

We will first consider *fear.* I believe that it can be shown that the emotion of fear can be elicited only in animals that utilize a motor mechanism in defense against danger or escape from it. The defense of the skunk is a diabolic odor which repels its gross enemies. The skunk has no adequate equipment for defense or escape by muscular exertion. The skunk has little or no fear. Certain species of snakes are protected by venom. They possess no other adequate means of defense or escape. They show little or no fear. Other animals, because of their prowess, have but few fears. The lion, the grizzly bear, and the elephant are examples. Animals having armored protection, as the turtle, have little fear. It is obvious that fear is not universal. Apparently the emotion of fear is felt only in those animals whose self-preservation is dependent upon an *uncertain* adequacy of their power of muscular exertion either in defense or in flight.

What are the principal phenomena of fear? They are palpitation of the heart, acceleration of the rate and alteration of the rhythm of the respiration, cold sweat, rise in body temperature, tremor, pallor,

erection of the hair, suspension of the principal functions of digestion, muscular relaxation, fixation of the muscles of the eyes, dilatation of the pupils. The function of the brain is wholly suspended, except that which relates to the self-protective response to the object feared. Neither the brain nor any other organ of the body can respond to any other lesser stimulus during the dominance of fear.

From the foregoing it would appear that under the influence of fear most, perhaps all, of the organs of the body are divided sharply into two classes: first, those that are *stimulated*, and, second, those that are *inhibited*. Those that are stimulated are the entire muscular system, vasomotor and locomotor systems, the senses of perception, the respiration, the mechanism for erecting the hair, the sweat-glands, the thyroid gland, the adrenal gland (Cannon), and the special senses. On the other hand, the digestive and the procreative functions are inhibited. What is the significance of this grouping? So far as we know, the organs stimulated include those, and only those, that increase the efficiency of the animal for fight or for flight. It is through skeletal muscles that the physical attack or escape is affected—these muscles alone energize the claws, the teeth, the hoofs, and the means for flight. The increased action of the heart and the adrenalin stimulation of the blood-vessels greatly increases the efficiency of the circulation; a much-needed increased efficiency to force the blood into actively contracting muscles; the increased action of the thyroid gland augments metabolic activity; there is no evidence that glycogen is actively called out, it being the most immediately available substance for the production of energy; the increased activity of the respiration is needed to supply the greater requirements of oxygen and the elimination of the increased amount of waste products; the dilation of the nostrils affords a freer intake of air; the increased activity of the sweat-glands is needed to regulate the rising temperature of the body due to the increased metabolism. The activity of the organs of perception—sight, hearing, smell—are heightened, so that the nature and the source of the danger may with the greatest certainty and accuracy be appreciated. It could not be a mere coincidence that the organs, and the tissues that are stimulated in the emotion of fear, are precisely those that are actually utilized in the perception of danger and in a physical struggle for self-preservation which might follow. Among the organs inhibited are those that have mainly to do with digestion and procreation. Why are these functions inhibited? If an animal could dispense with his bulky digestive organs, whose functions are suspended by fear; if he could, so to speak, clear his decks for battle, it would be advantageous. Although the marvelous versatility of natural selection apparently could devise no means of affording this advantage, it turned off the nervous current to these organs and saved the vital force which those *non-combatants* ordinarily consume in the performance of their functions. Whatever the origin of fear may be, its phenomena are apparently due to a *stimulation of all* the organs and tissues that add to the efficiency of a physical struggle for self-preservation through the motor mechanism, and an *inhibition of* the function of the organs

that do not participate—the non-combatants, so to speak. Fear arose from injury, and is one of the oldest and surely the strongest emotion. By the slow process of empiricism nature evolved the wonderful defensive mechanism of many animals and of man. *Now, the stimulation of this mechanism leading to a physical struggle is action, and the stimulation of this mechanism without action is emotion.*

We may say that fear is a *phylogenetic flight;* we fear not in our hearts alone, not in our brains alone, not in our viscera alone; fear influences every organ and tissue—each organ and tissue is stimulated or inhibited according to its use or hindrance in the physical struggle for existence. In thus utilizing all or most of the nerve force on the nervous muscular mechanism for defense alone, a greater physical power is developed. Hence it is that animals under the stimulus of fear are able to perform preternatural feats of strength. Then, too, for the same reason, the exhaustion following fear will be the greater, because the powerful stimulus of fear drains the cup of nervous energy, though no visible action may result. An animal under the stimulus of fear may be likened to an automobile with the clutch thrown out, but whose engine is racing at top speed. The gasolene is being used, the machinery is being worn, but the machine, as a whole, does not move, though the power of its engine may cause it to tremble.

Applying this conception to human beings of to-day, certain mysterious phenomena are at once explained. It must be borne in mind that man has not been presented with any new organs to meet the requirements of his present state of civilization; indeed, not only does he possess the same type of organs as his savage fellows, but also the same type of organs possessed by even the lower animals. In fact, the present status of civilization of man is now operated with the primary equipment of brutish organs. Contrasted with the entire duration of organic evolution, man has come down from his arboreal abode and resumed his new rôle of increased domination over the physical world but a moment ago. And now, though sitting at his desk in command of a complicated machinery of civilization, when he fears a business catastrophe it is in the terms of his ancestral physical battle in the struggle for existence. He cannot fear intellectually, he cannot fear dispassionately, he fears with all his organs, and the same organs are stimulated, and the same organs are inhibited, as if, instead of its being a battle of credits, of position or of honor, it were a physical battle with teeth and claws. Whether the cause of acute fear is moral, financial, social, or stage-fright, the same phenomena are seen. The phenomena are those of physical exertion in self-defense or escape. There is not one group of phenomena for the acute fear of the president of a bank in a financial crash; another for the trusted official who suddenly and unexpectedly faces the naked probability of the penitentiary, or of the hunter with an empty magazine and the grizzly still charging. Nature has but one means of response, and that means was acquired through vast periods of evolution, during which our progenitors struggled with bare hands

and naked bodies against wild beasts, and now, whatever the cause of fear, the phenomena are always the same—always physical.

From the foregoing, and from other considerations in biology, physiology, and the clinic, we are forced to conclude that man is, as Sherrington has well said, "a motor being." The mechanism that may be excited, and which may become exhausted and later deranged in the course of a surgical operation, is the motor mechanism. The particular part of the motor mechanism that is subject to exhaustion is the brain-cell. An adequate stimulus of any receptor, whether of the special senses or the receptors for pain, impinges upon the brain-cell and modifies it. Each time this occurs the brain-cell responds by giving up a certain amount of its energy, that is to say, the sight of the operating-room, the spoken word implying danger, the taking of the anesthetic, and the instrumental injury of tissue in the course of operation and the pull of the stitches after the operation, all are capable of stimulating the brain-cells and thereby causing them to use up their energy-giving substance. Excluding infection and hemorrhage, one could conceive of no influence whatsoever, aside from the factors mentioned, that plays any part in the production of surgical shock, postoperative pain, and later neurasthenia. Let us now picture the contact of a patient with his surgeon from the time of consultation until the patient is finally discharged. This contact may be divided into the following principal parts:

The first consultation, the period at the hospital up to the beginning of anesthesia, the anesthesia, the operation itself, and the convalescence. At any one of these points of contact the patient may receive injury and consequent impairment of the brain-cells. The want of tact in stating a diagnosis and recommending an operation may cause a very material mental shock; the lack of consideration of the patient after he enters the hospital up to the time that the anesthesia is begun may fill the patient with fear, hence, injury to the brain-cells; the kind of anesthesia and its method of administration may cause great excitement, hence, further damage to the brain-cells; every contact during the operation initiates impulses which reach the brain-cells and further impairs them; and, finally, inconsiderate nursing, rough dressings, and tactless contacts in the hospital during convalescence may add to the sum total of injury. The crucial question which now arises is this: What can be done to minimize or entirely abolish these several factors? First, it is only by experience and a sympathetic understanding of the sensibilities of patients that enables any surgeon, at the time of diagnosis and recommendation of operation, to reduce to a minimum the first personal contact. The pre-operative stay in the hospital can be made least harmful by the highest degree of efficiency on the part of the nursing and resident staff of the hospital, and by considerate attention to the details on the part of the operating surgeon, together with the administration of a small dose of morphin and scopolamin an hour and a half or two hours before the operation. As to the anesthetic, there are three factors—the first is, entire quiet, the avoidance of

everything suggesting the operation until the patient is unconscious; the second, the use of the pleasant nitrous oxid anesthesia instead of the repulsive ether; and, third, the administration of the anesthetic by a trained anesthetist, preferably a woman. The postoperative backache is minimized by a warm-water bed on the operating-table and propping up a patient after operation.

If the patient has received no damaging brain stimuli up to the point of the completion of anesthesia, the next question is, How can the damaging stimuli incident to the operation itself be prevented or minimized? It may be done by the use of novocain infiltration throughout the entire field of operation as completely as if the entire operation were to be performed under local anesthesia only. Under these circumstances the brain remains in a completely negative state during the entire operation, and no damage has been done to the brain-cells; hence, no surgical shock up to this point has been given.

The next point that arises is, How can we prevent the severe after-pains following abdominal operation, the so-called gas-pains, associated with distention and rigidity of the abdomen? First, let us consider the cause of these postoperative phenomena.

ON THE CAUSE AND THE PREVENTION OF POSTOPERATIVE GAS-PAINS.

The phrase postoperative gas-pains is intended to include a definite group of phenomena following operations which involve the peritoneum. These phenomena are painful rumbling of gas in the intestines with inability to pass flatus, associated with distention and some rigidity. The gas tends rather to come up into the stomach and may be eructated. The patient is frequently under the impression that there is obstruction, either mechanical or paralytic. There is anorexia, sometimes nausea or vomiting, and to a certain degree there is anxious facies. The abdominal pain and distention is in some cases distressing, and is a strong rival of ether anesthesia as the most unpleasant memory of a major operation. So far as I am aware, there have as yet been discovered no means of preventing it.

It is overcome measurably by enemata, and as soon as there is a free movement it disappears. The suffering is mitigated by hot packs and opiates.

This annoying, baffling phenomenon is associated only with operations that involve the peritoneum. But not every operation that involves the peritoneum is followed by it; viz., incision and simple drainage of local abscesses, incision without suturing the peritoneum, and especially immune are incisions into the peritoneum in vaginal punctures.

These, roughly speaking, are the types of operations that cause little or no gas-pains. On the other hand, the more nearly normal the peritoneum, and the more healthy the individual, the more marked is the gas-pain. They follow most herniotomies, appendectomies, gastric, gall-bladder, pelvic, and many renal operations; very marked gas-pains follow the cases in which a rough and persistent exploration is made.

It occurred to me to seek its origin in a general biologic law of adaptation; viz., that when the abdomen is penetrated, the phylogenetic association awakens the adaptive inhibition of the intestines so as to place the animal in the best state to localize and overcome infection following perforations. Loss of appetite and muscular rigidity and even vomiting are protective measures.

Now, this hypothesis put forward to explain adaptive phenomena can be easily put to a direct test as follows: The patient is anesthetized as usual, but the entire line of incisions is carefully blocked with novocain, including the peritoneum. If then, at the end of the operation, and before the peritoneum is closed, there is applied around the entire line of stitches a complete anesthetic block that will last a number of days, such as 50 per cent. alcohol or quinin and urea hydrochlorate, and if in stitching the peritoneum every stitch is placed within this blocked zone, then the afferent impulses caused by stitch irritation are blocked, and hence cannot excite this protective mechanism of intestinal inhibition. On trial of this method it was found that such blocking does minimize or even prevent postoperative gas-pains in all sorts of abdominal operations. The hypothesis is a part of the general principle of biologic adaptation.

A patient managed in this manner will have had excluded the various harmful influences or *associations*, which can be best designated by the word "noci-association"—that is, *nocuous* or harmful association. All the various factors which may injure the brain-cells are *noci-associations*. If, then, we so conduct the patient from the beginning to the end of his surgical contact that *noci-associations* are excluded, this state is best described by the new word *"anoci-association."*

The principle here enunciated has been more or less tested in a series of over 2000 operations by myself. This includes surgical risks of every description, in both private and ward patients, in the Lakeside Hospital. The mortality rate, which includes death from any cause in the hospital, is 2.1 per cent.

In the last 1000 the rate has fallen to 1.8 per cent.

But the most striking result is the almost incredible state of preservation of the patient's nervous equilibrium, and the extent of the diminution of postoperative discomfort.

Postoperative nausea or vomiting is much decreased; there are no backaches; little or no gas-pains or distention; the pulse-rate is never increased during the operation, not even in severe cases of Graves' disease, and, excepting in Graves' disease, the pulse-rate after the operation rarely shows a material rise; the use of the stomach-tube is almost unknown; the recovery room is no longer required, the patient going back immediately to the bed from which he came; the work of the nurse is greatly minimized, and, above all, more than 90 per cent. of patients thus operated upon have no unpleasant recollection of the day of their operation.

Summarizing, we may say, that many diseases act upon the brain-cells injuriously. Fear and trauma act in a similar manner. Thus

may the margin of safety in a surgical case be reduced. The conservation of this margin of safety is our urgent problem. If fear be excluded, and if the nerve-paths between the field of operation and the brain be blocked by local anesthesia, there will be no discharge of energy due to the operation; hence, there can be no shock, no exhaustion. Under these conditions of operation the nervous system is protected against *noci-association*, whether by *noci-perception* or by an adequate stimulation of *nociceptors*. The state of the patient in whom all *noci-associations* are excluded can be described only by coining a new word. That word is "*anoci-association*."[1]

[1] For Crile's suggestions as to anesthesia by nitrous oxid and oxygen, see his chapter, Vol. VI., p. 950.

CHAPTER XCIX.

FRACTURES.[1]

By Daniel N. Eisendrath, M.D.,

Chicago.

Pathologic Fractures From Bone Cysts.—The subject of bone cysts interests not only pathologists, but surgeons as well. During recent years a number of cases of spontaneous or pathologic fractures have occurred as the result of the development of a bone cyst in the shaft of the long bones. These cysts may be single, but not infrequently are multiple. None of the long bones seem to be especially exempt from invasion by this process of inflammation. Considerable difference of opinion exists among pathologists in regard to the pathogenesis of the process. The majority, however, are agreed that it is a low grade of inflammation, termed osteitis fibrosa, somewhat allied to osteomalacia and to rachitis, and results in the formation of a large cyst-like cavity in the shaft of the long bones. The shaft of the bone is greatly expanded as the result of the presence of the cyst, the cortex being especially thin, so that fracture readily occurs. Fletcher and a few others have claimed that the cysts are the result of the softening of sarcomata or of chondromata. This may be true for some of the cases, but is not so for the majority. I have had two of these cases of bone cysts, in both of which the presence of the bone cyst was only suspected when a spontaneous fracture occurred. The *x*-ray appearance of these tumors is very characteristic (Fig. 23). The cortex is almost as thin as tissue paper and shows the line of fracture quite distinctly. The medulla, instead of showing a relatively dark shadow, is exceedingly clear and often shows trabeculæ in the wall of the cyst. The treatment of these cases is practically always of a surgical nature. Thorough drainage of the cyst, with evacuation of its contents, has been successful in a number of cases. H. M. Sherman and others have attained equally good results by filling the cavity with salt solution. After thorough curettage of the cyst and filling it either, as suggested by Sherman, with normal saline solution or with bismuth paste, these can be treated further as a simple fracture. Union usually occurs somewhat more slowly than in the case of ordinary fracture. Refracture occurred in one of my own cases two years after apparent union.

Compound Fractures.—But little change has taken place during the past five years in the treatment of compound fractures. The general attitude of the most progressive surgeons is that conservatism should be

[1] Supplementary to Chapter XXIV., Vol. II., p. 75.

our keynote in the treatment of such an injury. Instead of the elaborate method of disinfection hitherto in use, it has been found sufficient to simply shave the skin thoroughly, taking care to scrub away from the wound. Tincture of iodin may be employed, instead of the ordinary method of disinfection with green soap and water, etc. The iodin is applied directly to the skin without shaving it, and is applied in two or three coats. Many surgeons are employing this method of disinfection with tincture of iodin in preference to the more complicated methods, and report equally good results with its use. It is certainly much simpler, and involves far less risk of carrying dirt from

FIG. 23.—BONE CYST (AT UPPER END OF LEFT HUMERUS IN BOY OF TWELVE) CAUSING SPONTANEOUS FRACTURE. ARROW POINTS TO LINE OF FRACTURE.

the surface into the wound and thus infecting the fracture seat. The *majority of compound fractures are not infected, and often only become so through meddlesome interference.* In Vol. II. the details of the conservative treatment have been taken up as well as the method of disinfecting the deeper parts in those compound fractures where we have good reason to fear a primary infection, *i. e.*, at the time of injury.

Another step in advance in the treatment of compound fractures is the more systematic use of antitetanic serum as a prophylactic measure, giving 1500 to 3000 units as a preventive dose. This is now employed as a routine measure in many hospitals, the dose not being as large as would be given for a curative purpose, but of the amount usually given

for immunization; that is, about half of the ordinary first dose given for curative purposes.

A few surgeons employ the Lane bone-plate in order to secure accurate apposition in cases of compound fracture, but, in my own opinion, this practice is not to be encouraged. It is best to wait for a week or ten days, in order to escape the danger of infection which is likely to occur when the bone-plates are used in compound fractures. Not infrequently a recent compound fracture becomes infected as the result of such manipulation, resulting in necrosis and delayed union. This has been more fully discussed under the heading Operative Treatment of Simple Fractures.

METHODS OF EXTENSION IN FRACTURES OF THE EXTREMITIES.

Owing to their belief that it is impossible in many cases of fractures of the extremities to obtain accurate apposition by the use of any of our modern methods of extension, German surgeons have been warm advocates of utilizing other means. Since 1907 a large number of articles have appeared in German surgical journals advocating the use of one of the three newer methods of extension, viz.: the Bardenheuer method, the Steinman method, and that of Zuppinger.

Bardenheuer's Method of Extension.—The first to suggest the use of weight as extension, applied with an adhesive-plaster dressing, were American surgeons—Gross (in 1830), Gurdon Buck, Crossby, and others. They applied it in fractures of the femur. The method was introduced into Germany and on the Continent in general by von Volkmann. Bardenheuer, of Cologne, has systematically developed the method, and has introduced a number of changes during the past thirty years. The theory of Bardenheuer is the following: The chief cause for the development of malposition and the maintenance of this malposition of fragments in fractures is the retraction of all of the tissues which surround the fracture, especially of the muscles. Since the cause of the dislocation or displacement of the fragments is an active living power or force, it is necessary to bring into play a permanently acting force to counteract it. The bloody infiltration of the musculature and other tissues around the fracture is followed by secondary inflammation, and the muscles are in that way shortened as the result of connective-tissue formation within the muscle itself. At the same time, there is a connective-tissue transformation of the entire exudate around these fragments at the seat of fracture. The object of the Bardenheuer permanent extension is to overcome this elastic and inflammatory muscular retraction. We have been accustomed to think that it is necessary only to overcome muscular contraction. This contraction does not last long, since the muscles easily become tired out. Hence, in order to overcome the more important factors of muscular retraction as a result of connective-tissue formation, it is necessary to bring extension into play as early as possible in order to retain as far as possible the normal muscular elasticity. Through the use of extension the retracted muscles are permanently stretched, and the fragments may then

be brought into apposition. Since the muscles around a fracture do not all act in one direction, it is not sufficient, according to Bardenheuer, to overcome the longitudinal pull; that is, to apply extension only in a longitudinal direction, but we must apply extension in the different directions in which the muscles which cause the displacement act. By overcoming only longitudinal displacement it is possible to get a good anatomic result in only a very small proportion of cases. Hence, it is also necessary to overcome the rotary and lateral displacements. These other forms of displacement—that is, overriding or lateral dis-

FIG. 24.—MODE OF ACTION OF TRANSVERSE AND LONGITUDINAL TRACTION IN FRACTURES OF SHAFT OF FEMUR, TREATED BY BARDENHEUER METHOD.

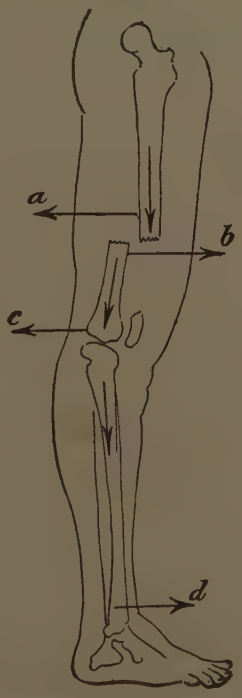

FIG. 25.—LATERAL VIEW OF RELATIONS SHOWN IN FIG. 24.

placement and rotary—can only be overcome if the longitudinal displacement has been previously corrected in a proper manner. With the aid of such longitudinal, transverse, and rotary pull or methods of extension, Bardenheuer believes that he can overcome the various forms of displacement. The chief objections to the Bardenheuer method are that it is not adapted for use by the general practitioner. It requires an immense amount of care on the part of the surgeon, daily control, the use of more or less extensive apparatus, and, finally, a considerable knowledge of mechanics in order to apply the apparatus correctly. It is a method which is chiefly applicable to hospitals, and even there

cannot be entrusted to inexperienced hands. I doubt whether the method of Bardenheuer will ever be a very popular one for this reason.

Technic of Extension According to Bardenheuer.—One of the first requisites is a bed with a firm hair mattress, since the extremities come in direct contact with it and no splint or sliding apparatus is used. The best adhesive plaster is that which is now in general use, namely, the so-called zinc oxid adhesive plaster, causing very little irritation, even though it be left in contact with the skin for a considerable period of time. The longitudinal extension is applied along the entire length of the limb, and not from the distal fragments alone, as is so frequently the case in applying the ordinary Buck's extension. By applying the adhesive plaster along the entire length of the extremity the extension acts upon the superficial and deep fascia, and through it upon the mus-

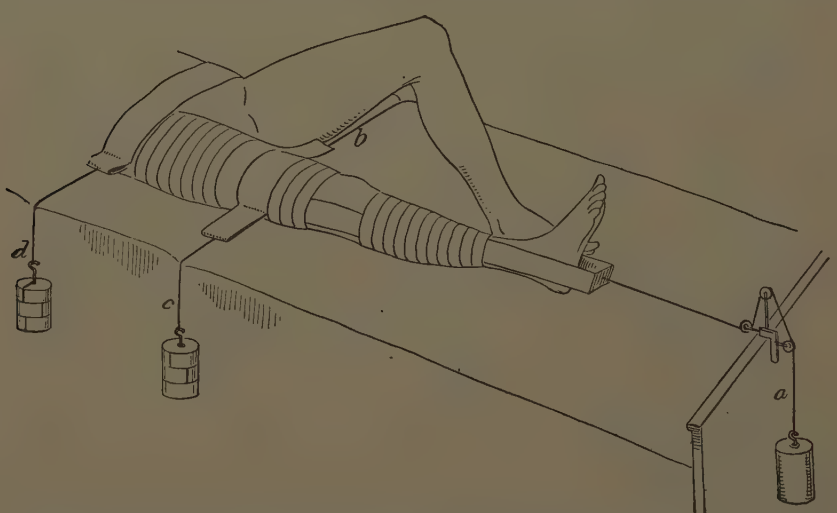

FIG. 26.—MODE OF ACTION OF TRANSVERSE AND LONGITUDINAL TRACTION IN FRACTURE OF NECK OF FEMUR, ACCORDING TO BARDENHEUER METHOD.

cles, and in that way upon the periosteum and the fracture fragments. The accompanying illustration (Fig. 26) will serve to show the various methods of applying this method to fractures of the lower extremity. For all such fractures except those of the lower third of the leg proper, the method of applying extension is quite similar to that familiarly known as the Buck method of extension. The chief differences from this well-known method, introduced by Bardenheuer, is to leave the knee and ankle-joint free (Fig. 26), and also to apply the adhesive plaster as high as the upper border of the trochanter on the outer side of the limb, and to a corresponding point on the inner side. In order to avoid hyperextension at the knee a sand-bag or soft pillow is placed under the knee.

For fracture of one or both bones in the lower third of the leg, in addition to the ordinary Buck's extension, as modified by Bardenheuer,

he uses a method of extension (Fig. 27) which reinforces the other extension and makes more direct traction upon the seat of fracture. The ankle-joint itself is protected by a small gauze compress. Two figure-of-8 strips of adhesive plaster are now carried around the ankle-joint, the lower strip being placed so that its center lies over the dorsal aspect of the ankle-joint, while its two ends are crossed just below the insertion of the tendo achillis. The upper strip is so placed that its middle lies over the tendo achillis, the ends crossing on the extensor side of the

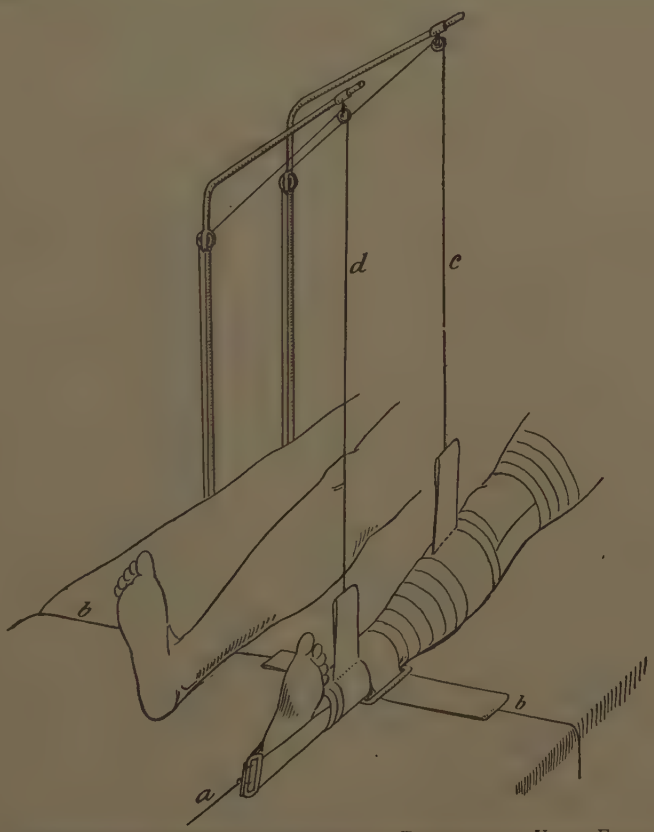

FIG. 27.—BARDENHEUER'S METHOD OF EXTENSION IN FRACTURES OF UPPER END OF TIBIA.

ankle-joint. They are then united on the lower side or, rather, beneath the longitudinal extension (Fig. 27). A weight of from 12 to 20 pounds is put on the lower pieces of adhesive plaster.

In the upper extremity, longitudinal extension is always accomplished by placing adhesive-plaster strips on the anterior or flexor and posterior or extensor surfaces of the extremity, with ample protection for the olecranon processes. The wrist- and elbow-joints are left free. The same is true of the forearm and arm proper for about 2 inches above and below each of these joints. Counterextension is made by

raising the head of the bed (Fig. 29). If there is marked abduction, for example, of the upper fragment in cases of fracture of the surgical neck of the humerus, the extension can be made with marked abduction of the entire arm (Fig. 30). Traction in the direction at right angles to the longitudinal axis of the limb can be readily applied, both in the case of the upper and lower extremity, by applying adhesive plaster at the point at which traction is desired, and carrying it in a similar manner, described under the ordinary Buck's extension method, across the side of the bed (Fig. 31). The adhesive plaster, passing around the limb in order to make lateral traction, is either sewed or fixed by means

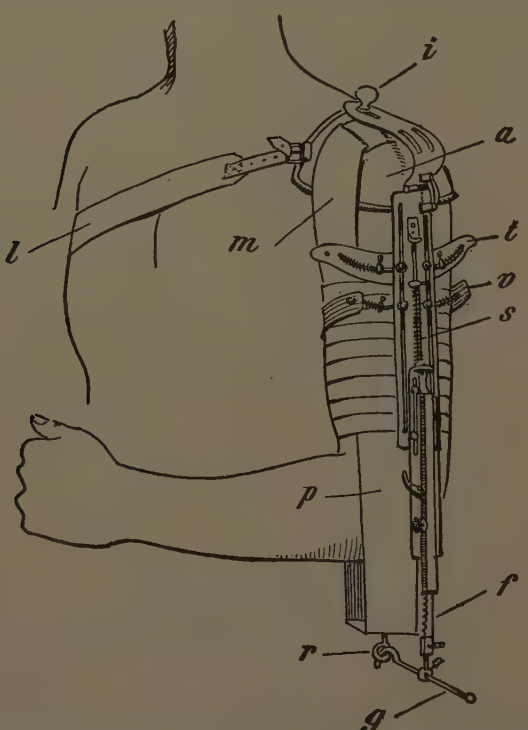

FIG. 28.—BARDENHEUER'S COMPLICATED EXTENSION APPARATUS FOR FRACTURES OF SHAFT OF HUMERUS.

of a safety-pin at a point exactly corresponding to the middle of the limb toward which traction is desired. In case it is advisable to have rotary traction this circular piece of adhesive plaster can be united; that is, either sewn or pinned at a point corresponding to the upper or lower level of the limb, depending upon the direction in which rotary traction is desired. Traction at right angles to the longitudinal axis can be exerted either in a horizontal or vertical plane.

The theory upon which these methods of overcoming the various displacements are based is quite apparent from the preceding description. The method of application has just been described. Figs. 29–31

will show how this is accomplished. Bardenheuer employs a considerable amount of weight. Objection has been raised to this on the part

FIG. 29.—BARDENHEUER'S METHOD OF LONGITUDINAL EXTENSION IN FRACTURES OF UPPER END OF HUMERUS.

of other surgeons, who state that not infrequently it is followed by much muscular weakness and very lax joints.

In cases of impacted fracture, correction of the deformity is usually accomplished immediately by anesthetizing the patient. This is espe-

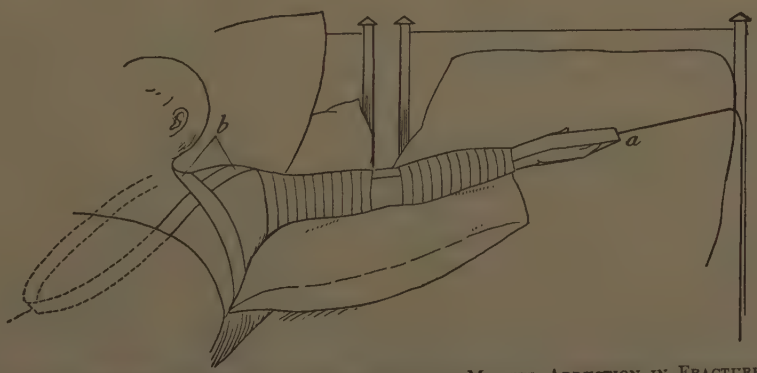

FIG. 30.—BARDENHEUER'S METHOD OF EXTENSION WITH MARKED ABDUCTION IN FRACTURES OF SURGICAL NECK OF HUMERUS.

cially true of impacted fractures of the lower end of the radius or of fractures of the forearm with angular displacement. In cases of frac-

ture of the neck of the femur or of the upper end of the humerus with impaction no effort is made to correct it, even though there be a considerable amount of deformity. One can gain an idea of the enormous weights which are employed by Bardenheuer when one recalls the fact that in order to correct longitudinal displacement in cases of fracture of the shaft of the femur he uses nearly 60 pounds of weights. For correcting lateral displacements—that is, for the transverse traction—he uses about 10 pounds of extension. For the treatment of fractures

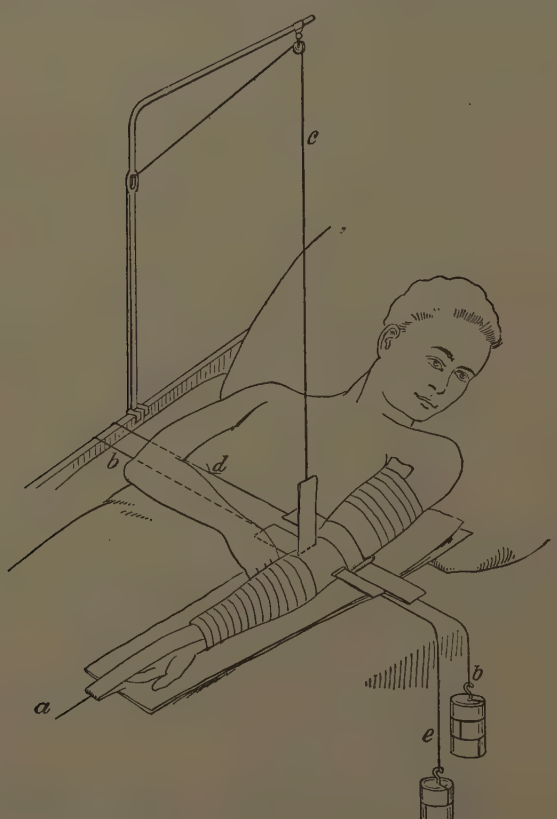

FIG. 31.—BARDENHEUER'S METHOD OF OVERCOMING FORWARD DISPLACEMENT OF LOWER FRAGMENT IN FRACTURES OF LOWER END OF HUMERUS.

of the upper extremity, Bardenheuer has devised a number of very complicated splints which require great mechanical dexterity to adjust and to watch. Those interested in the details of the method will find a more complete description in Bardenheuer and Graessner's book, published in 1905.

Steinmann's Method of Extension of Fractures by Nails.—Steinmann, of Lucerne, in 1907,[1] was the first to describe a method of inserting a steel nail into the epiphyseal end of the distal fragment of fracture.

[1] Zentralbl. Chir., 1907, p. 938.

By means of an apparatus (Fig. 32) extension was then made on the distal fragment. This method has attracted a great deal of attention in Germany, and has as many opponents as supporters. The insertion of nails into the distal fragment for the purpose of extension was devised independently by Steinmann, who claims to have been ignorant of a previous publication of Codivilla in 1903. Steinmann also claims that his method differs in principle from that of Codivilla, inasmuch as the nails are inserted directly into the distal fragment of the broken bone, and its application is not limited to the lower extremities, but has been used equally as much in fractures of the upper extremity, whereas Codivilla has only employed the method in the lower extremities by inserting a nail into the os calcis. The question as to whether a nail should be inserted into each side of the distal fragment, or through the entire fragment from one side to the other, is still a matter of debate. Becker[1] claims priority for the suggestion that the nails should be inserted through the entire thickness of the shaft of the bone. Steinmann himself believes that this method is not as good as his own. He now employs a long, slender nail (Fig. 33).

Fig. 32.—Principle of Applying Extension by Use of Nails. (Steinmann.)

Wilms has been a warm advocate of this method, and uses a broader nail, with a notch on one side, in which the extension is applied. Many opponents of the method claim that the nail enters the spongy portion of the bone, penetrating the cortex, and becomes loosened very readily. The method of inserting the nails is as follows: The patient is anesthetizd, and after thorough disinfection of the skin a small incision is made and the thoroughly disinfected nail is inserted. Steinmann claims that primary infection is practically impossible, and that he has never

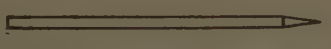

Fig. 33.—Form of Round Nail Employed by Steinmann.

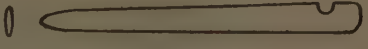

Fig. 34.—Form of Flat Nail Employed by Wilms.

seen any inflammatory reaction. Others, however, have observed infection a number of times.

Anschutz[2] saw one infection in 12 cases. He believes that it is of special value in old fractures or in certain forms of delayed union and in compound fractures, in which there is extensive destruction of the skin and infection of the soft parts.

[1] Zentralbl. Chir., 1908, p. 1417.
[2] Münch. med. Woch., 1909, No. 33.

Steinmann's method is not without its disadvantages, and cannot be considered as a normal method to reduce displaced fragments. It requires constant control and observation, and cannot supplant either Bardenheuer's or any other method of adhesive-plaster extension. It overcomes the longitudinal displacement better than the lateral. For recent fractures Steinmann claims that it is not necessary to use such heavy weights as in adhesive-plaster extension. Morian[1] and others claim to have observed infection very frequently after inserting the nails, so that it was necessary to remove them. The extension itself is practically painless when the nails are used.

Wilms employs a weight of about 25 to 30 pounds at first; later, 12 to 18 pounds. The complete reposition of the fragments is usually accomplished by the sixth day, so that after that time one scarcely needs more than 12 pounds. In some cases the displacement of fragments is even overcorrected, diastasis resulting.

If the semiflexed position is used in recent fractures, it is not even necessary to use as much weight as when the leg is straight. Wilms employs flexion in the upper extremities and in the complicated T-fractures of the humerus, and believes it is the best method of treatment. If the nail passes through the entire thickness of the bone from one side to the other, there is no danger of injuring vessels or nerves, according to Wilms.

Anschutz believes that it is of use only if other extension methods cannot be employed, and all agree that it is excellent for fractures which offer great obstacles to reduction. In addition to the danger of infection, other disadvantages have been spoken of in recent articles, such as pressure gangrene of the skin at the place where the nail passes through it; loosening and rotation of the nails; overcorrection, with resulting formation of false joints, and in young idividuals one cannot overlook the possibility of endangering the integrity of the epiphyseal cartilage.

The method has been described here at length, since it has met with such warm discussion in Germany, and is well worthy of a trial under proper precautions, when it is impossible to apply other methods of extension.

Zuppinger's method of extension[2] for the treatment of fractures has also been the subject of much discussion in Germany, and is sufficiently employed to justify its description here. Zuppinger's objections to the ordinary methods of extension are that they produce considerable damage to the muscles, which later causes lengthening of the period of invalidism, the patients not being able to work for a much longer time than he thinks ought to be the case. He believes that the necessary lengthening of the muscles can be accomplished without using heavy weights. He accomplishes this without extension by semiflexion of the hip and knee, according to a method which equalizes muscular tension (Figs. 35 and 36).

[1] Med. Klin., 1909, 885.
[2] Beit. klin. Chir., vols. xlix. and lxiv., pp. 176–178.

Montandon[1] and Henschen[2] have made a careful study of the mechanico-physiologic condition of the muscular and connective tissue in their relation to fractures. They have demonstrated the correctness of Zuppinger's views that the elastic pull of the muscles, which is the cause of the displacement of the fragments of a fracture, can be best eliminated by placing the joints which are involved in a semiflexed position.

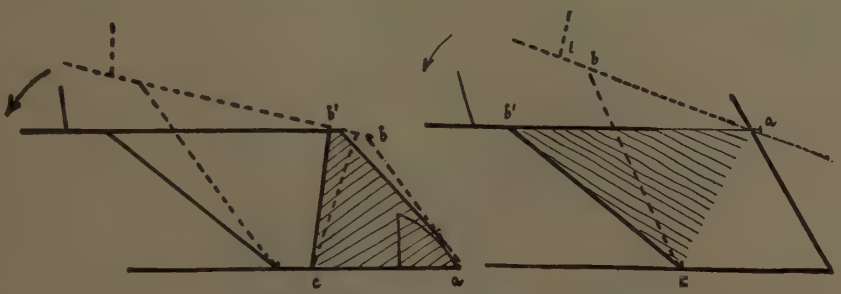

FIG. 35.—PRINCIPLE OF ZUPPINGER'S METHOD OF EXTENSION.

Whatever tension still remains can be overcome by a very slight amount of extension, much less than would be required if the extension were made with the limb in an extended position.

Vogel[3] has also confirmed these views by actual measurements, and comes to the conclusion that the best relaxation of the muscles of the lower extremity can be attained through a moderate degree of flexion

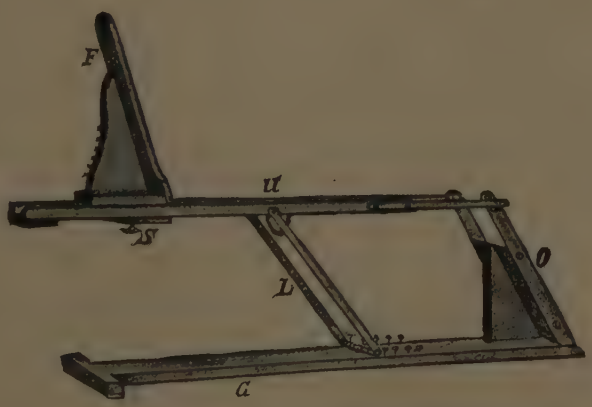

FIG. 36.—APPARATUS FOR ZUPPINGER'S METHOD OF EXTENSION.

of the hip and the knee. The need of producing relaxation of the muscles is not a new principle, having been brought forward by Pott as early as 1768, and since that time a number of forms of apparatus have been suggested to bring about these results.

[1] Arch. Gen. de Chir., 1908, p. 2.
[2] Beit. klin. Chir., vol. lvii.
[3] Heilkunde, 1908, p. 358.

The apparatus known as Hennequin's, extensively employed in France, is based upon this principle, but the results with it have not been satisfactory enough to cause its general adoption.

The application of Zuppinger's method is shown in Figs. 36 and 37. Zuppinger and the school of Krönlein see great advantages in extension in the semiflexed position over the method of Bardenheuer, which they regard as a relatively rigid extension system, whereas theirs is a flex-

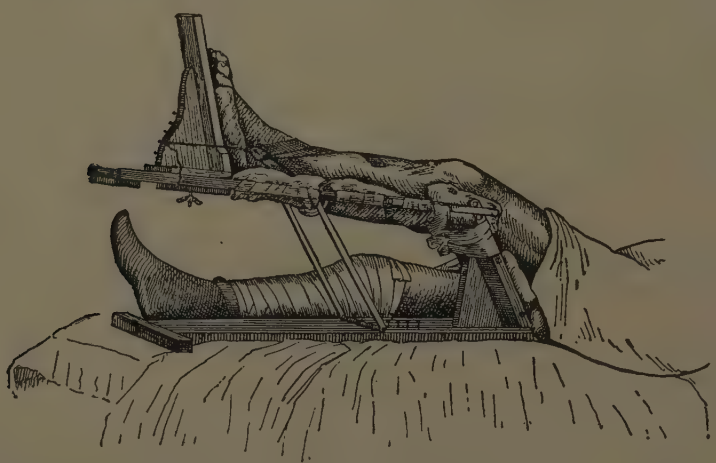

Fig. 37.—Zuppinger's Apparatus in Use.

ible, mobile system which also requires less weight. They do not agree with Bardenheuer's statement that the flail joints, which so frequently remain after using heavy weights, are due to relaxation of the ligaments and joint capsules, but they believe that it is due to the artificial relaxation and overstretching of the muscles resulting from an excessive amount of longitudinal pull, the elasticity of the muscles being entirely obliterated by the method of Bardenheuer.

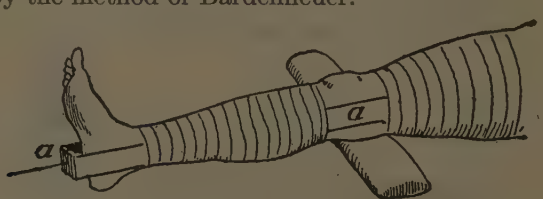

Fig. 38.

Henschen and Webstein report excellent results obtained by the use of Zuppinger's method, at the Surgical Congress in 1908.[1] The number of cases which had been treated by the method was not large, the results that had been obtained in the relatively short time were excellent from a functional standpoint, but there was not always good anatomic apposition. Secondary shortening was quite frequent, although the shortening has been primarily overcome.

[1] Zentralbl. f. Chir., 1908, p. 153.

Bardenheuer believes in the principle of relaxation of the muscles in the treatment of fractures, and applies it in the treatment of fractures

FIG. 39.

of the upper extremities, but he has been unable to obtain as satisfactory results in fractures of the lower extremities by the use of Zuppinger's method as with his own.

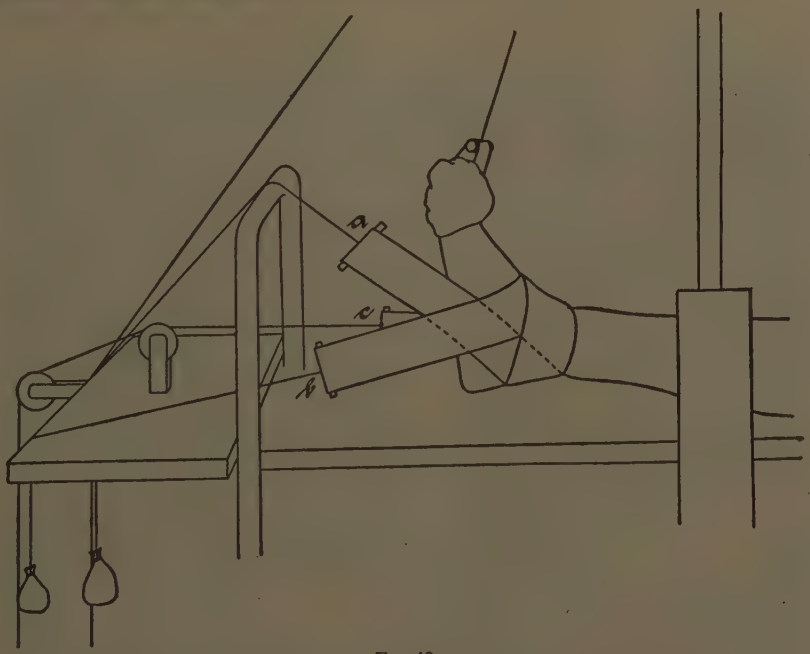

FIG. 40.

The application of transverse or rotary traction is very difficult in the Zuppinger method, and Bardenheuer believes that the time has not yet come for its more general use. There have been so many improvements in the different forms of Zuppinger's apparatus that nothing re-

mains except the principle. None of these methods, in my own opinion, is yet sufficiently well established to displace the standard methods

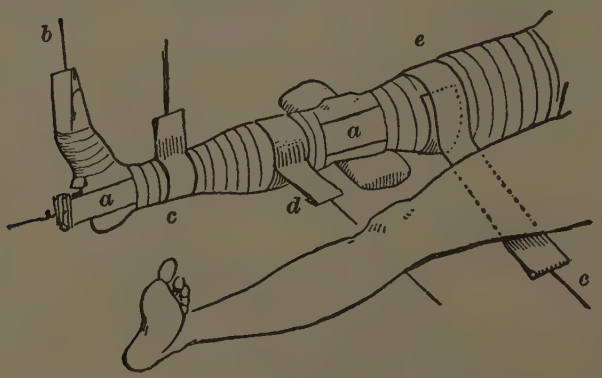

Fig. 41.

of extension as employed in America or England, except under special conditions.

I believe that all three of these methods of extension will not remain as permanent aids in the treatment of fractures of the long bones.

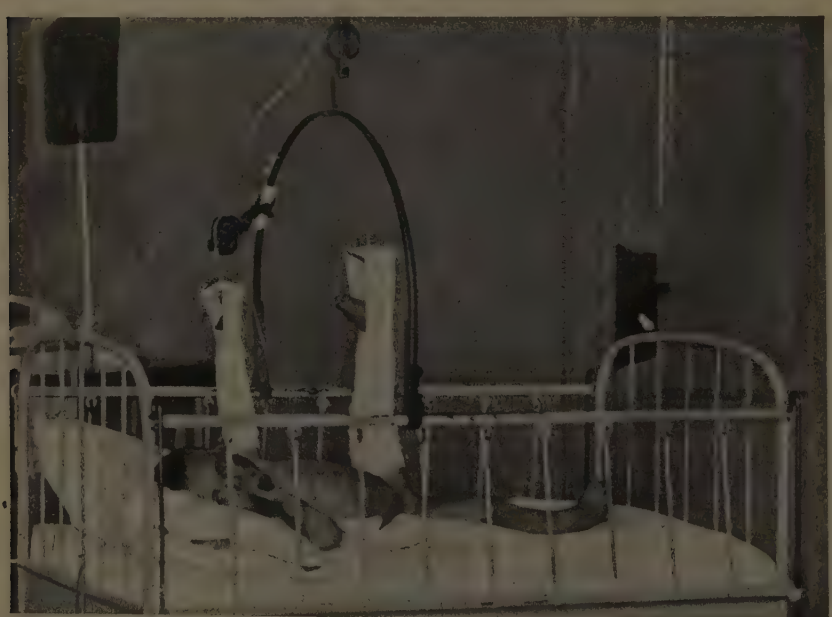

Fig. 42.—Apparatus for Application of Extension in Fractures of the Femoral Shaft of Children, According to the Schede Method.

The apparatus is too complicated and requires too much personal attention ever to become very popular.

OPERATIVE TREATMENT OF SIMPLE FRACTURES.

In Vol. II., p. 123, this subject was discussed fully. Since the publication of these views there has been very active interest in the question. Some surgeons have taken the radical position that in every fracture whose fragments cannot be brought into accurate apposition operative interference is indicated. A second group of equally competent and experienced surgeons hold the more conservative view that but few fractures should be operated upon, and that a good functional result will follow non-operative methods of treatment, although the anatomic result leaves much to be wished for. The safest and sanest position would seem to be one midway between the radical and conservative groups. The chief objections to the radical view are the following: (1) Many fractures are treated by the general practitioner or those whose experience in surgery is limited. (2) An *x*-ray picture will not infrequently give an exaggerated idea of the amount of displacement. Inspection and palpation will reveal little if any deformity, yet the radiograph will show a much greater relative displacement. (3) Many cases with a relatively poor anatomic result will give an excellent functional result.

So far as the general question of operative interference is concerned, the generally accepted view at the present time is that of those who hold a middle position. If the conditions, so far as asepsis is concerned, are perfect, if it is impossible, after repeated manipulations under anesthesia, to obtain a satisfactory reduction, and finally, if the surgeon has a knowledge of the special mechanical appliances which are now in use, operative measures should be resorted to early. *No class of operations requires a more perfect degree of asepsis than those upon fractures.* Much of the feeling of discontent with the use of the Lane plates is due to the fact that the details of asepsis and of a well-equipped armamentarium have been overlooked. As is true of so many waves of enthusiasm which follow the introduction of new methods in surgery, and their application to all classes of cases and by many men without the proper facilities and training, the result has been that the Lane method has suffered from much unjust criticism.

We have at present three methods of holding fragments of fractured bones in apposition after an open reduction. These are:

1. The use of some absorbable suture material, like kangaroo tendon.

2. The use of silver or bronze-aluminum wire, of steel nails, or special steel clamps, like the Gussenbauer or the Parkhill.

3. The use of the Lane bone-plates.

Kangaroo Tendon.—In fractures of the patella the majority of operators obtain most satisfactory results by bringing together the edges of the torn aponeurosis and periosteum, without penetrating the bone itself. For this operation and for the smaller bones in adults, like the clavicle, metacarpals, etc., as well as all of the bones in children, except the tibia and femur, this suture material is ideal in every respect.

Wire, Nails, Ivory Pegs, and Clamps.—The field of usefulness of all of these has become more limited, having been supplanted in many cases by the Lane bone-plates. Steel nails and ivory pegs are most satisfactory in fractures of the neck of the femur. Silver or bronze-aluminum wire, introduced through the cortical layer on the side toward the operator only, do not maintain apposition of the fragments as firmly as plates, but will suffice in many cases if plates are not available. Clamps have won but few supporters, although Dr. Leonard Freeman states that he has been well pleased with the results obtained by employing a clamp of his own.

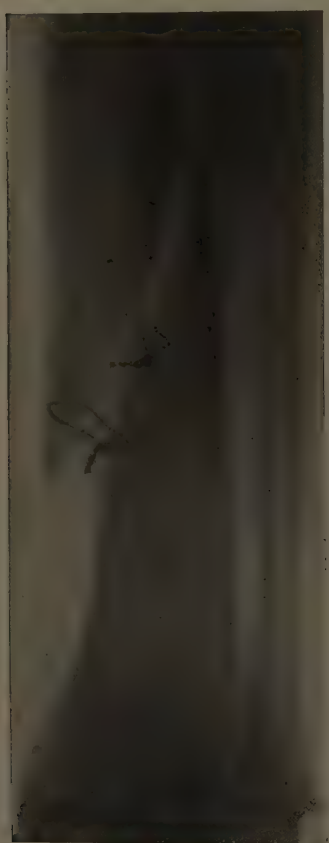

FIG. 43.—COMPOUND (SPIRAL) FRACTURE OF MIDDLE OF TIBIA.
Fragments united by silver wire. Excellent fractional result in spite of overlapping.

FIG. 44.—COMMINUTED FRACTURE OF BOTH BONES OF LEG BEFORE USE OF LANE PLATE. (L. L. McArthur.)

Use of the Lane Bone-plates.—In 1905 Mr. Arbuthnot Lane, of London, in his "Operative Treatment of Fractures," stated that he had made it his habitual practice for the preceding thirteen years to operate on all cases of fractures of the long bones in which he was not able to obtain accurate apposition of fragments. The majority of his illustrations are those of spiral fractures. That this form is far more frequent than formerly believed, and much more difficult to reduce than any other variety, has been described on p. 187. In his later articles, Lane says that he had extended his method so as to include almost every fracture.

This radical position is much to be deplored for the reason stated on p. 175. There is, however, little difference of opinion in regard to the great value of the method in cases in which reduction is impossible, or when the fragments, even after reduction, cannot be held in place, and in cases of delayed or non-union. The objections to the method are that, if the least degree of infection occurs, the plate acts as a foreign body and a sinus persists until the plate is removed. The Lane technic must be followed if the danger of infection is to be reduced to a minimum. The chief points as recommended by Mr. Lane are:

FIG. 45.—COMMINUTED FRACTURE OF BOTH BONES OF THE LEG AFTER USE OF LANE PLATE. (L. L. McArthur.)
Compare with Fig. 44.

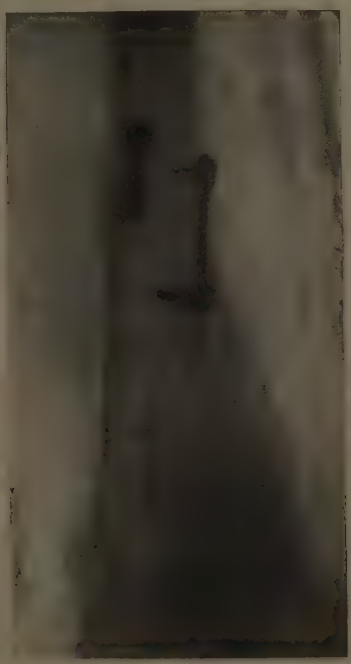

FIG. 46.—X-RAY TAKEN THROUGH PLASTER CAST OF COMMINUTED FRACTURE OF BOTH BONES OF LEG AFTER USE OF LANE PLATE. (L. L. McArthur.)
Compare with Fig. 44.

(1) Special forceps secure the edges of the sterile sheets to the under surface of the divided skin margin. The operator and all assistants should wear rubber gloves, and great care should be exercised so that the fingers do not enter the wound, and that no instruments which have been touched are allowed to come in contact with the exposed tissues. There should be a minimum amount of manipulation of the exposed fragments and as little of the periosteum stripped off as possible.

(2) The bone-plates commonly used, called the Lane plates, are made of fine grade, cold rolled, blue steel, provided with four to eight reinforced screw holes, arranged in series of two, three, and four at each end, with a strong, solid band between. The steel screws

are threaded to their heads, and are of such length that when driven home they reach to the medullla, passing through one cortical thickness. No screw should ever be placed nearer than ¼ inch from the seat of fracture.

Many surgeons use a special bone-clamp to hold the plate in position, while a bone-drill bores holes preparatory to inserting the screws. A very useful instrument is one to hold the screws in position while they are being driven into the holes made by the drill. Edward Martin[1] has had a special plate made of vanadium steel, and uses a special bone clamp and screw, which have proved to be of great service. After insertion of the plate and suture of the wound a plaster cast is applied. Until some appliance is devised to hold fragments in position, which will have the strength of the Lane plates, but will be absorbable, the Lane plate can be warmly recommended, if used when indicated and with the precautions as to asepsis, etc., above described. Suppuration may necessitate removal of the plate, but even in such cases much good will have been accomplished by its use.

Dislocation and Fractures at the Anterior End of the Rib.—Separations of the ribs from the sternum occurs relatively rarely. They are usually the result of direct violence, such as crushing of the chest. The displacement of the cartilage may be either forward or backward. Except for the local tenderness, the slight deformity, and the occasional soft crepitus on respiration and cough there are no special symptoms. Practically the diagnosis rests on palpation, and in the absence of displacement, on tenderness. The treatment consists of attempts by pressure to reduce the displacement. If successful, the displaced cartilage can then be held in place by strapping in the manner customary with fractures of the rib. If necessary an aseptic gimlet could be introduced, in order to make traction on one fragment while the other fragment is pressed backward.

Separation of the costal cartilages from each other may occur either between the sixth and the seventh, or between any of the ribs from the sixth to the tenth. It is usually the result of direct violence from crushing of the chest, or from a simple blow or fall so received elsewhere on the rib as to be transmitted to this point. The diagnosis rests upon localized tenderness and some pain on breathing. Upon manipulation there is often a soft click to be felt, due to one cartilage sliding upon another. The immobilization of the chest usually gives instant relief.

Dislocation of the rib from the cartilage occurs more commonly than either of the last two (Cotton). The costochondral articulation forms a distinct joint deformity which may easily be separated, giving rise to quite noticeable deformity. The dislocation can usually be readily reduced and held in place with a strip of adhesive plaster.

[1] Surg., Gyn., and Obst., August, 1911.

SPECIAL FRACTURES.

Fractures of the Elbow.—Classification of Fractures of the Elbow in Children.—In addition to the well-recognized varieties, such as (1) supracondylar (including T- and Y-fractures), (2) separation of the whole epiphysis, (3) separation of the external condyle, and (4) separation of the internal epicondyle, I also believe that the variety described by Kocher as the diacondylar, and so well illustrated in Ashhurst's recent essay on fractures of the elbow, deserves to receive a place as a fifth variety.

The suggestion of Cotton[1] to separate fractures of the elbow into two classes—those of adults and those of children—is a very practical one, because some of the fractures which occur in children are not found in adults, and there is apt to be less confusion when they are spoken of

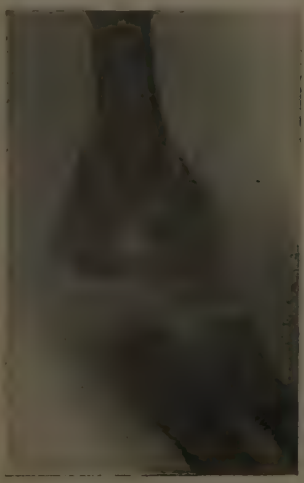

FIG. 47.—Y-SHAPED FRACTURE OF LOWER END OF HUMERUS IN A GIRL OF TEN. (Michael Reese Hospital.)

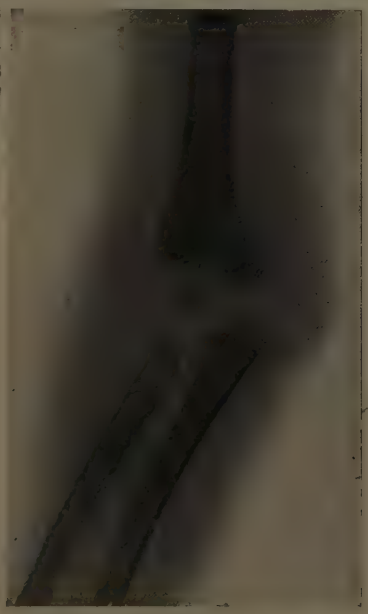

FIG. 48.—DIACONDYLAR FRACTURE OF LOWER END OF HUMERUS.

separately. In the former are included the following varieties: (1) Supracondylar; (2) T-fracture; (3) fracture of the external condyle; (4) of the external epicondyle; (5) of the capitellum; (6) of the internal condyle; and (7) of the internal epicondyle.

Treatment.—The standard method of treatment for the majority of fractures of the lower end of the humerus still remains the immobilization of the elbow in flexion at a right angle. The treatment by acute flexion is used by comparatively few surgeons. It is especially indicated where there is a marked tendency toward backward displacement. The extended position is rarely employed.

Fractures of the Lower End of the Radius.—The routine use of the *x*-ray has taught us much in regard to the different varieties of

[1] Fractures and Dislocations, 1910.

fractures of the lower end of the radius and ulna, as well as the study of fractures of the carpal bones. One of the most interesting papers in the recent literature of this subject is that of Lilienfeld.[1] He examined 115 cases with the *x*-ray. Only a few cases, that is, those in which no displacement exists, heal with a perfect anatomic result. In all others one can find displacement. One of the chief points of interest in his paper, and one which I have found true in a large number of my own cases, is that the majority of such cases are typical Colles' fractures with impaction. The main object of our reduction should be to *break up this impaction.* Lilienfeld's cases were those which had been sent to his Institute for passive movement, etc., on account of more or less

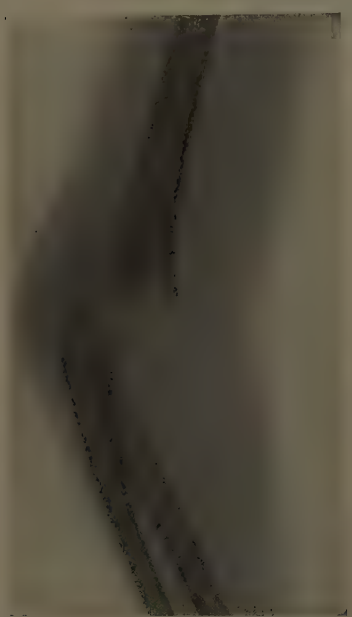

FIG. 49.—SIDE VIEW OF LOW SUPRACONDYLOID (DIACONDYLAR) FRACTURE OF HUMERUS.

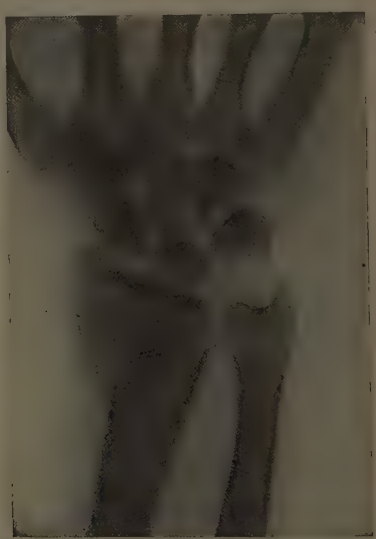

FIG. 50.—IMPACTED FRACTURE OF LOWER END OF RADIUS (TYPICAL COLLES' FRACTURE WITH IMPACTION).

stiffness of the wrist-joint. He believes that the proper method of treating Colles' fractures is to place the patient under an anesthetic and make reduction by means of strong traction, thus breaking up the impaction. In 115 Colles' fractures he found more than 50 per cent. of them impacted. Many of them are accompanied by fractures of the carpal bones. There may be only a fissure without separation, but in other cases the *x*-rays show us a dislocation of the carpal bones. In 44 of his 115 cases a fracture of the styloid process of the ulna accompanied it. There is no doubt in my own mind that many of the deformities following Colles' fracture are due to the fact that frequently this impaction is not recognized. One cannot too strongly urge the surgeon to take careful *x*-ray pictures of these injured extremities in two direc-

[1] Archiv., klin. Chir., vol. lxxxii.

tions, namely, in an anteroposterior and a lateral position. Not infrequently the impaction is seen in one position better than in the

FIG. 51.—ANTEROPOSTERIOR VIEW OF IMPACTED COLLES' FRACTURE. (Michael Reese Hospital.)

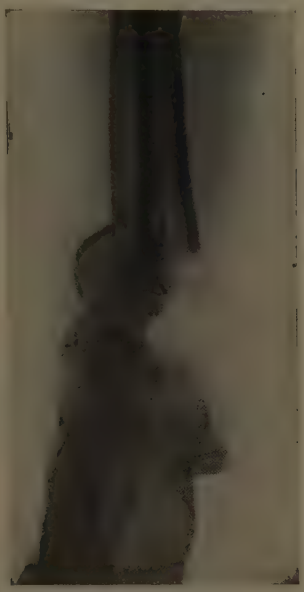

FIG. 52.—IMPACTED FRACTURE OF LOWER END OF RADIUS (TYPICAL COLLES' FRACTURE WITH IMPACTION).

other, and one should never be content with simply a view in the anteroposterior direction, so customarily taken. The detection and early

FIG. 53.—IMPACTED COLLES' FRACTURE WITH DISPLACEMENT TOWARD RADIAL SIDE. (Michael Reese Hospital.)

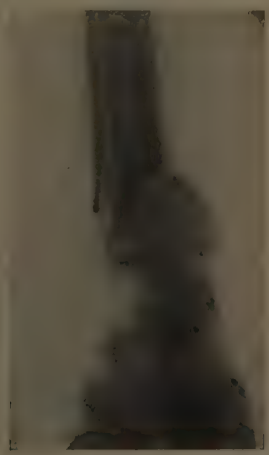

FIG. 54.—LATERAL VIEW OF IMPACTED COLLES' FRACTURE WITH TYPICAL BACKWARD AND UPWARD DISPLACEMENT OF LOWER FRAGMENT.

breaking up of this impaction will certainly create quite a difference in our results in the future.

Fractures of the Carpal Bones.—This subject is discussed at length in Vol. II., p. 209. It was formerly believed that isolated fractures of the carpal bone were of rare occurrence. The routine use of the *x*-rays

FIG. 55.—FRACTURE OF CARPAL BONES AND LOWER END OF RADIUS IN BOY OF TEN.
Anteroposterior view.

FIG. 56.—FLEXION DEFORMITY FOLLOWING FRACTURE OF THE CARPAL BONES.
Laterial view of Fig. 55.

in the examination of injuries of the lower end of the radius and ulna has shown that a fracture of a single carpal bone may occur even though there is no associated injury. We may have isolated fractures of any of the seven carpal bones. Of course the scaphoid and semilunar are

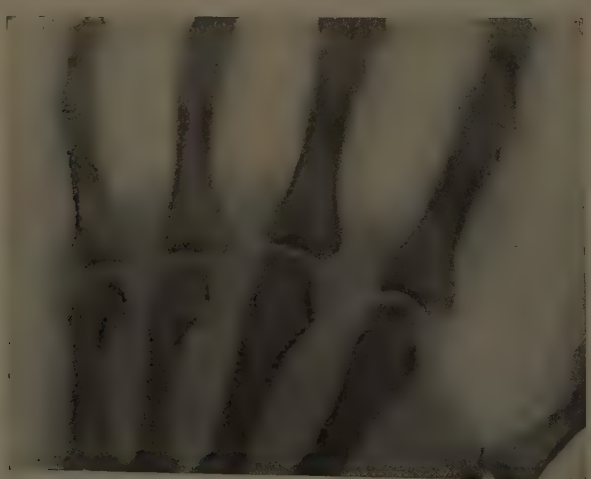

FIG. 57.—FRACTURE THROUGH NECK OF METACARPAL BONE OF LITTLE FINGER WITH ANGULAR DISPLACEMENT.

the bones most commonly involved, but it must be borne in mind that any of the others may be broken alone. An interesting contribution is that of Finsterer.[1] In addition to 5 of his own he collected 33 cases

[1] Beiträge klin. Chir., vol. lxiv.

from literature. None of these were caused by direct violence, the mode of production usually being that of compression after falls on the forearm or hand while the latter was in dorsal flexion. There is usually no crepitus. The anteroposterior diameter of the wrist is increased, and there is limitation of extension and great pain upon attempts to extend the wrist.

A very characteristic symptom is intense pain upon tapping directly over the proximal end and head of the third metacarpal bone. One should always take *x*-ray pictures in two directions. The suggestion of Codman for taking pictures of the scaphoid, by placing the two wrists of the patient in adduction, would apply equally well to the semilunar, by changing the position to that of abduction.

FIG. 58.—TRANSVERSE FRACTURE OF BOTH BONES OF FOREARM, ANTEROPOSTERIOR AND LATERAL VIEWS, IN A BOY OF TEN.

These two illustrations emphasize the necessity of taking views of a fracture in two directions. In the lateral exposure a marked displacement is seen.

The deformity when present should be corrected by traction, and movements begun as soon as possible—*i. e.*, after the third week. If the deformity cannot be corrected by manipulation, operation must be resorted to.

Fractures of the Neck of the Femur in Adults.—Treatment by Royal Whitman Method.—The so-called abduction method of treatment of these fractures has gained in favor since the former chapter on fractures was written. Whitman and others have warmly recommended its use. A body cast is applied while an assistant slowly, and under gentle traction, abducts the injured limb, the surgeon meanwhile supporting the joint with his hand and pressing gently downward upon the

trochanter. When the normal limit has been reached a long plaster cast is applied. The cast is strengthened beneath the joint by a bar of steel or aluminum shaped like the Thomas' hip splint. The leg, when the cast is completed, is in an abducted position, as near to 45 degrees as possible.

Fractures of the Neck of the Femur in Early Life.—Whitman's view that the majority of cases of fracture of the neck of the femur in early life are true fractures and not epiphyseal separations is generally supported by increasing experience in this country. Foreign writers still cling to the idea that the injury at the neck of the femur is more frequently an epiphyseal separation than a true fracture, as Whitman maintains. Figure 59 was taken from an injury of the neck of the femur in a boy of ten who had fallen from a third story window, sustaining at the same time a spiral fracture of the shaft of the humerus

FIG. 59.—FRACTURE OF NECK OF FEMUR AT JUNCTION WITH SHAFT IN A BOY OF TEN. (Michael Reese Hospital.)

and a contusion of the kidney. Examination of this radiograph supports the view of Whitman, namely, that the fracture is a true one of the neck of the femur, resembling to a great extent that occurring in adults.

Fractures of the Acetabulum.—That fractures of the acetabular rim are not as infrequent as had been thought before the use of the *x*-rays was referred to in the former chapter. During the past few years we have also learned that many of the acetabular fractures are truly also central dislocations of the hip, that is, fractures of the acetabular cup or cotyloid cavity, more or less complete, with dislocation of the head of the bone through the fracture opening into the pelvis. This is fully discussed in the supplementary chapter on Dislocations (Vol. VI., p. 208).

Isolated Fracture of the Lesser Trochanter.—Pochammer[1] reported a case of isolated fracture of the lesser trochanter which was

[1] Archiv. klin. Chir., vol. xci.

diagnosed by the deep-seated pain over the lesser trochanter, inability to lift the limb, or to flex or extend it at the hip. The diagnosis was confirmed by a skiagraph.

Dislocation of the Hip Complicated by Fracture of the Neck of the Femur.—Monks[1] reports 2 cases of this rare form of injury. One of these was an anterior dislocation (pubic) of the head of the right femur, complicated with fracture through the neck of the bone. The dislocation was reduced, but death occurred a few hours later. The second case was also an anterior dislocation (low thyroid) of the head of the femur, complicated by fracture of the great trochanter and of the acetabulum. Monks has only been able to find a few cases of dislocation of the hip

Fig. 60.—Obturator Dislocation of Hip with Fracture of Neck of Femur. (Own case.)

complicated with fracture of the neck of the femur. In some of them the dislocation was of the posterior variety and in others of the anterior. In the large majority of the cases the fracture was either through the shaft of the bone or through its neck. In only a few of the cases where the fracture was through the neck of the bone did the fracture occur at the same time as the dislocation. The fracture usually resulted from attempts to reduce the dislocation. I have had one case of disclocation of the hip of the forward variety associated with fracture of the neck of the femur. In this patient both injuries occurred at the same time. Reduction of the fracture was impossible by any of the ordinary

[1] Annals of Surg., Sept., 1911.

methods, the head of the bone lying directly over the obturator foramen. Operative reduction confirmed the diagnosis, the fracture of the femur being at the neck with the shaft (Fig. 60).

Separation of the Lower Epiphysis of the Femur.—This form of epiphyseal separation is second in frequency to that of separation of the upper epiphysis of the humerus. Reduction in many of the cases is practically impossible without operative interference. In 2 cases which I have encountered during the past few years it was necessary to operate in order to effect reduction. In both of them the most characteristic findings before operation were the mushroom-like end of the

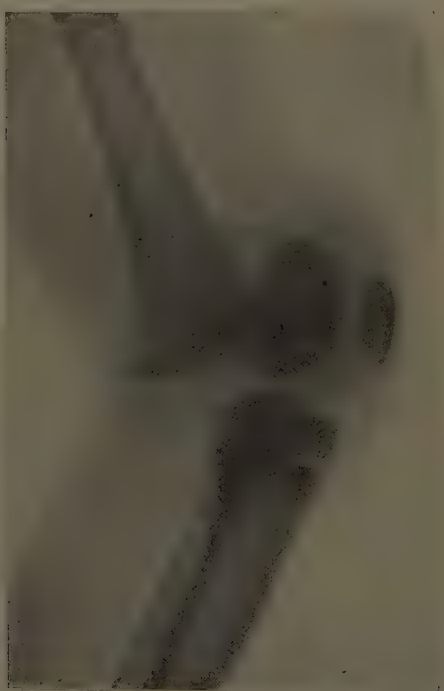

Fig. 61.—Epiphyseal Separation of Lower End of Femur in a Boy of Twelve Years. Note displacement backward of upper fragment.

shaft felt in the popliteal space. In one case the fragments lay almost beneath the skin. The prominence of the tilted lower epiphyseal fragments on the anterior aspect of the knee is also quite characteristic. Reduction in both cases was rendered impossible on account of the turning in of the periosteum and ligaments over the cup-like depression on the upper surface of the epiphysis. One was complicated by a primary tear of the external popliteal nerve by the edge of the fracture.

In many cases of fracture of the shaft of the long bones in children, and especially in epiphyseal separation which require operative interference, kangaroo tendon suffices as a suture material. It was employed in both of the above cases with very satisfactory results. The leg should

be slightly flexed at the knee, in order to relax the pull of the gastrocnemius muscle. The cast should remain for at least four weeks. No cases have been reported, so far as I know, of injury of the blood-vessels in the popliteal space as a result of the displaced upper fragment, but such a sequel might easily follow.

Fractures of the Long and Short Bones in General.—Spiral Fractures of the Long and Short Bones.—One of the most important developments in the routine use of the *x*-ray in the diagnosis of fractures has been to show that spiral fractures of the long bones are far more frequent than was thought to be the case. Many of the cases of impossible or, at least, difficult reduction of fractures are the result of such long spiral fragments. Muscular and periosteal interposition occurs quite readily in such fractures, and the long tongue-like ending of the fragments renders reduction exceedingly difficult. This is especially true of fractures of the

FIG. 62.—SPIRAL FRACTURE OF MIDDLE OF SHAFT OF FEMUR WITH MARKED LATERAL DISPLACEMENT OF FRAGMENTS.

FIG. 63.—SPIRAL FRACTURE OF SHAFT OF TIBIA. (Michael Reese Hospital.)

long bones of the lower extremity, namely, the femur and the tibia. Even when operative interference has been resorted to, exact apposition, that is, the fitting of the tongue of one fragment into the corresponding gap in the opposite fragment, is very troublesome. Rotary displacement is also quite common and demands early consideration in the treatment. A careful study of a large number of skiagraphs of such fractures has shown that there are two types of spiral—(1) the short type, with a quite prominent tongue-like projection at the end of each fragment, the tongues being on opposite sides of the shaft;

and (2) a longer, more tapering spiral form. It is to this latter class of spiral fractures to which Lane had special reference in his first monograph on the Operative Treatment of Fractures. It cannot be denied that this variety more frequently calls for operative interference than any other form of fractures of the long bones on account of the difficulty of reduction.

Fractures of the Tarsal Bones.—Since the former section (Vol. II., p. 273) was written Stealey[1] has collected all of the literature on fractures of the astragalus up to 1909. He found that death from septicemia was frequent in compound fractures. Necrosis of the unreduced dislocated fragment is frequent in simple fractures. Hence, if markedly

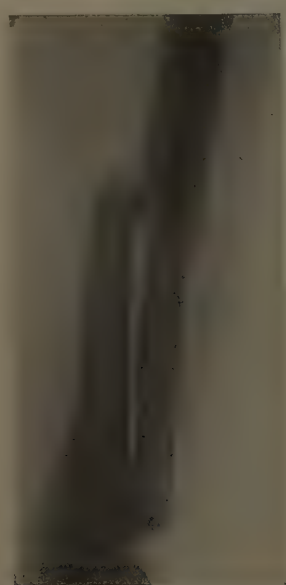

FIG. 64.—FRONT VIEW OF SPIRAL FRACTURE OF BOTH BONES OF THE FOREARM (BEFORE REDUCTION).

Reduction very difficult on account of locking of fragments.

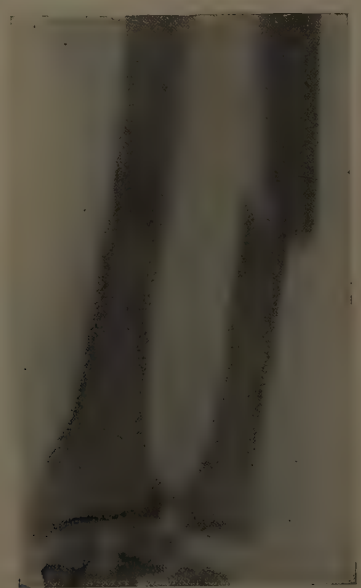

FIG. 65.—SPIRAL FRACTURES OF RADIUS AND ULNA (LATERAL VIEW).

displaced fragments are present which cannot be readily reduced, it is best to replace them by open operation or to remove them. In compound fractures, seen for the first time twenty-four hours after the injury, it is best to remove the loose fragments.

Cotton and Wilson,[2] from a study of 100 cases of fracture of the os calcis treated at the Boston City Hospital, come to a similar conclusion as in the cases of astragalar fracture above referred to, viz., that if reduction by manipulation is impossible it is best to operate. It is important, in all fractures of the tarsal bones, not to permit weight to be borne until after the second month. For old fractures, with pain and deformity, a flat-foot brace or osteotomy are indicated.

[1] Surg., Gyn., and Obst., Jan. 1909.
[2] Boston Med. and Surg. Jour., Oct. 29, 1908.

Isolated Fractures of the Tarsal Bones.—It is now a generally accepted fact that although not as frequent as fractures of the astragalus or os calcis, fractures of the other bones may occur as isolated injuries, and are not by any means as rare as was formerly thought. Hoffman[1] collected 22 cases of isolated fracture of the tarsal scaphoid and believes it is often treated as a sprain unless a skiagraph is taken. If the fragments cannot be reduced, he advises operation. In recent cases the foot should be placed in a cast and kept in a pes varus position. Weight should not be placed on the foot for two months. Cook[2] has another good article on the same subject, and says one must not

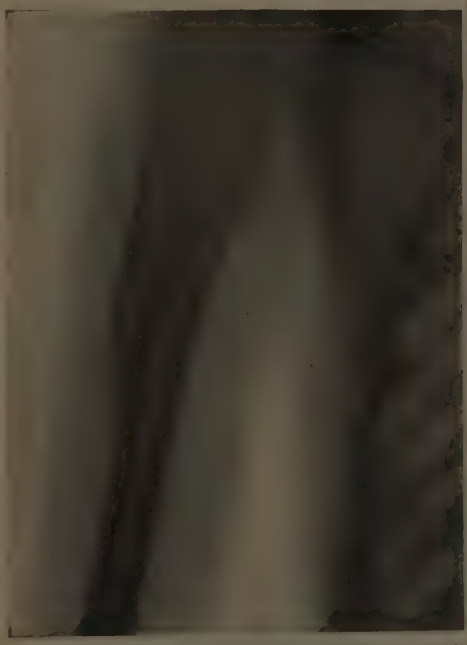

FIG. 66.—TYPICAL SPIRAL FRACTURE OF MIDDLE OF SHAFT OF HUMERUS. (Michael Reese Hospital.)

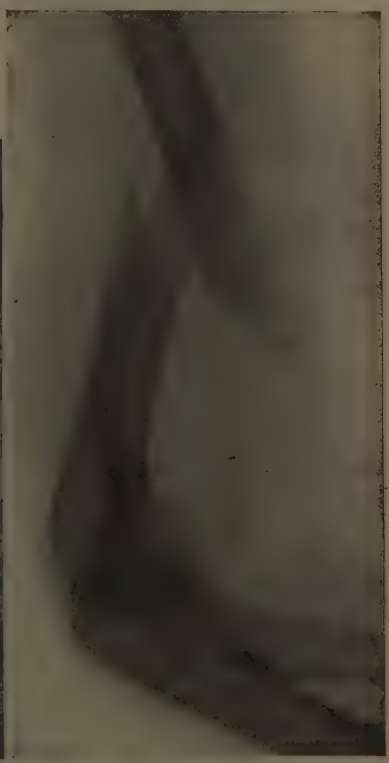

FIG. 67.—SPIRAL FRACTURE OF MIDDLE OF SHAFT OF HUMERUS, WITH MARKED ANGULAR DISPLACEMENT.

These are very difficult to reduce, as explained in the text.

forget that the presence of sesamoid bones may cause one to think a fracture is present, and one must also remember that the tubercle of the scaphoid may remain as a separate bone.

Ginterman[3] reports a rare case of isolated fracture of the cuboid. The signs were localized pain, crepitation, abnormal mobility, pain on pronation and supination, and a prominence on the outer side of foot.

[1] Beiträge klin. Chir., vol. lix., 1908.
[2] Annals of Surg., vol. xlvi.
[3] Archiv. klin. Chir., vol. xci.

Fractures of the Upper End of the Radius and Ulna.—Radiographic examination of a large number of injuries of the elbow has shown

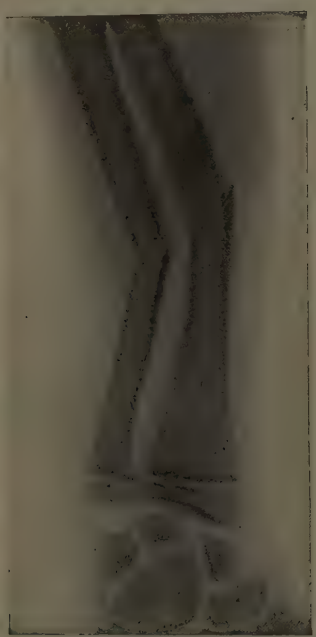

FIG. 68.—GREENSTICK FRACTURE OF BOTH BONES OF FOREARM.

It is best to convert such a fracture into a complete one by breaking in the opposite direction.

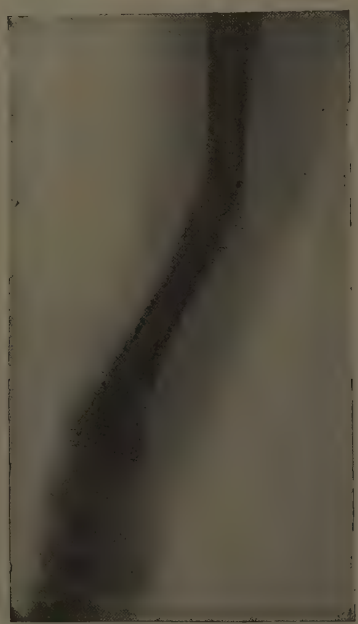

FIG. 69.—SIDE VIEW OF GREENSTICK FRACTURE OF MIDDLE OF FOREARM.

This would persist unless conversion into complete fracture was effected.

FIG. 70.—FRACTURE OF OS CALCIS.

that all varieties of fractures of the head, neck, and upper third of the radius and upper third of the ulna occur. These injuries are:

(1) Comminuted fractures of the head of the radius.

(2) Complete or incomplete vertical fractures of the radial head.

(3) Transverse or spiral fractures of the neck of the radius.

(4) Oblique or spiral fractures of the upper third of the radius and ulna at the same or at different levels.

FIG. 71.—INCOMPLETE FRACTURE OF OLECRANON.
Note fissure with slight separation of fragments.

(5) Spiral or transverse fractures of the upper third of the ulna, with fracture or dislocation outward or forward of the radial head.

(6) Incomplete or complete fractures of the olecranon.

One must bear all of these isolated or combined injuries in mind, since an oversight may cause permanent injury as the result most often of malunion with rotary or angular deformity. It is not at all rare to overlook an associated dislocation of the radial head unless *x*-ray pictures in both anteroposterior and lateral directions are taken.

If the deformity cannot readily be reduced, it is best to resort to early operative interference.

CHAPTER C.

THE PATHOLOGY OF CHRONIC ARTHRITIS.[1] [2]

By Edward H. Nichols, M. D.,

Boston.

There has been always much confusion in regard to the lesions in chronic non-tuberculous disease of the joints, due to the fact that the study of these joints has been chiefly clinical, and from clinical symptoms alone it is impossible to determine the type of anatomic change present in a given joint.

Pathologically, the lesions represent different stages in two distinct types of joint disease. These two distinct types present marked clinical differences in the later stages of their progress, and slight but distinct differences in their early stages. The two types also show clear differences of causation.

There are two pathologic types of joint lesions in chronic non-tuberculous joints: (1) The *ankylosing type*, leading to joint ankylosis, in which the primary change in the joints is a proliferation of the connective tissue, chiefly of the synovial membrane, which leads to joint ankylosis and partial or complete obliteration of the joint cavity. (2) The *degenerative type*, in which the primary change in the joint is a degeneration, fibrillation, and destruction of the joint cartilage, with resulting irregularity of the joint facets, but with retention of the joint cavity.

These two anatomic types of joint lesion can readily be distinguished macroscopically and microscopically, but *they do not correspond to two single etiologic factors*, i. e., *to two definite diseases*. This point cannot be emphasized too strongly. Various causes may produce the lesions associated with anchylosis of the joints; the causes include all bacterial infections, some cases of faulty metabolism, and certain forms of trauma. In general, these causes can be distinguished from those which produce degenerative changes. The causes which produce degeneration of joint cartilage include some other forms of trauma, and probably most cases due to faulty metabolism of a different type from that which produces the anchylosing type.

In most of these joints of both types the original cause continues to act over a long period, and at different times produces a great variety of gross appearances with corresponding variation of symptoms, dependent upon the duration of the process and upon various incidental

[1] Supplementary to Chapter XXV., Vol. II., p. 282.

[2] "Arthritis Deformans," by Edward H. Nichols and F. L. Richardson, Jour. of Med. Research, Sept., 1909, pp. 149–221.

factors. In other words, a given cause in either of the two anatomic types produces a considerable variety of gross appearances, with a corresponding variety of symptoms, or one of a variety of causes may, in either type, lead to a similar end-result. Mere examination of the joint may fail to show which one of a number of possible causes was the actual cause in the special case.

1. **Ankylosing Arthritis.**—The series of changes seen in joints of this type arise from a variety of causes, which, in general, are different from those which cause degeneration of the joint cartilage; the changes occur, *e. g.*, after acute suppuration due to pyogenic bacteria, after gonorrheal infection, in the so-called Still's disease, after the occurrence of gumma in the epiphysis adjacent to the joint, after fracture into joints with dis-

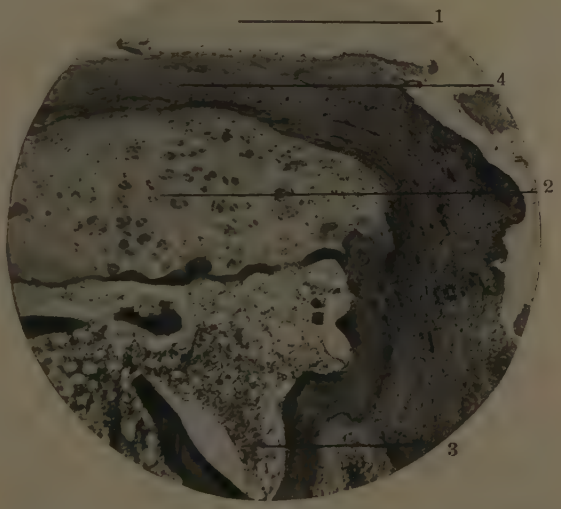

FIG. 72.—ANKYLOSING ARTHRITIS, EXTREME TYPE, CAUSE UNKNOWN.

Photomicrograph of the margin of the articular surface of a phalanx. Shows granulation tissue extending over the joint cartilage from ingrowth of the granulation tissue: 1 shows the joint cavity; 2, the articular cartilage; 3, the shaft of the phalanx. The joint cartilage is covered with a thick layer of granulation tissue, 4, which extends from the synovial membrane over the surface of the cartilage.

placement of the fragments, and in a group of cases in which the onset is insidious, with no evidence of bacterial infection. These latter cases are, in all probability, due to faulty metabolism. The evidence in favor of the theory that some of these cases are due to metabolism is, in the present state of our knowledge of physiologic chemistry, purely inferential, but is based upon the facts that the cases begin insidiously, continue over long periods with remissions, often are associated with intestinal indigestion, and, in many cases, are relieved by treatment of the intestinal condition.

The process consists chiefly of a proliferation of the synovial membrane of the joint, which extends over the joint cartilage as a "pannus" and becomes adherent to it. Wherever this ingrowing pannus is in contact with the cartilage it causes, secondarily, destruction of the

cartilage, and this destruction ultimately may be complete. Wherever the layers of pannus are in contact with each other they tend to adhere, thus causing fibrous ankylosis of adjacent bones, and leading to more or less obliteration of the joint cavity, either by dividing the joint into loculi or, in some cases by adhesions, leading to complete obliteration of the joint cavity.

There also may be destruction of the base of the joint cartilage from the side of the epiphysis, due to the formation of granulation tissue in the narrow spaces of the epiphysis. This granulation tissue destroys the cartilage from the side of the epiphysis, just as the "pannus" does from the joint surface. If the destruction of the cartilage is complete,

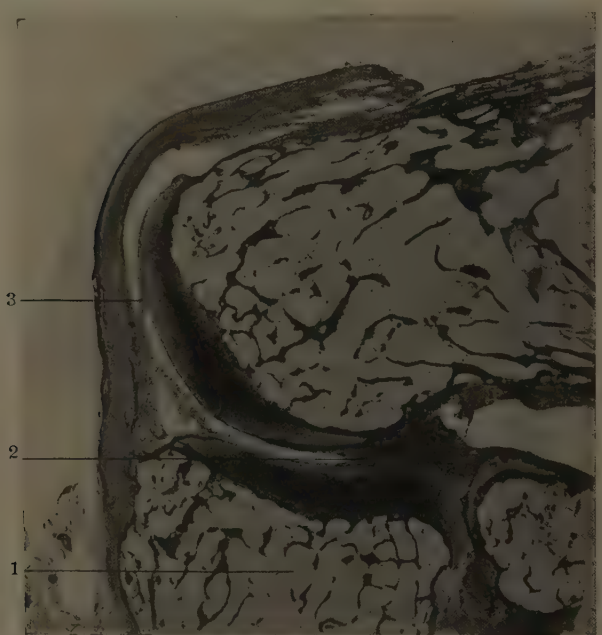

FIG. 73.—ANKYLOSING ARTHRITIS, FAIRLY EARLY STAGE.

Photomicrograph of section through phalangeal joint. Shows adhesions between the capsule and the articular cartilage, with partial obliteration of the joint: 1 is the phalanx dislocated forward; there is a marked degree of encroachment of the synovial pannus, 2, firmly uniting both phalanges; there also is a moderate amount of adhesion between the joint capsule and the exposed end of the phalanx, 3.

the "pannus" and the granulation tissue from the epiphysis unite. These two layers of granulation tissue are both destructive (Fig. 72).

In addition to these destructive processes, there is in most of these joints an attempt at repair. The perichondrium covering the articular cartilage may proliferate and lead to the formation of, at first, fibrous tissue, which later may transform into cartilage or bone. At the same time there may be formed new bone about the trabeculæ of the epiphysis. These two processes are the result of an attempt at repair (Fig. 73).

Hence, in a word, two layers of granulation tissue form in ankylosing joints, one layer derived from the synovial membrane, one from the

connective tissue of the marrow. There also are two layers which act to produce new cartilage or bone, namely, the perichondrium of the joint and the endosteum of the epiphysis. All four layers may proliferate together, so that within the joint destruction of cartilage and new formation of cartilage or bone may take place, while from the side of the epiphysis likewise destruction of joint cartilage or deposit of new bone may occur. After the original cartilage has been destroyed the proliferating areas become united and fused into one, and

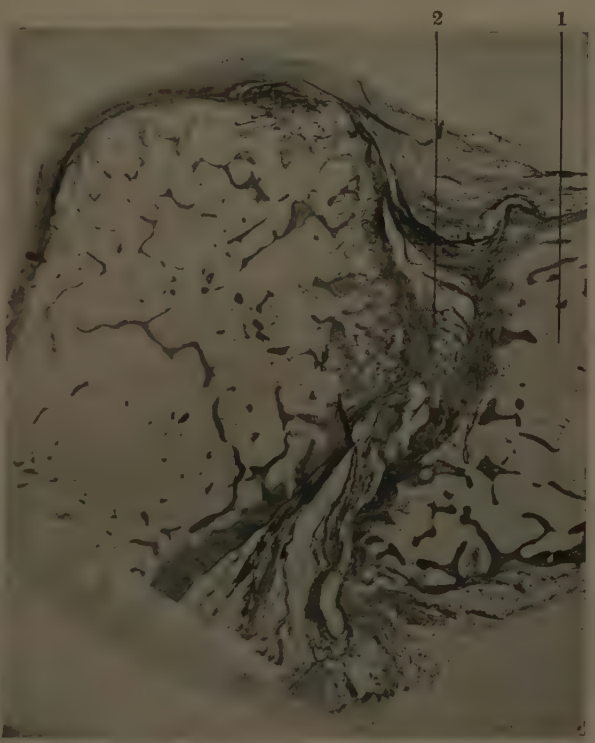

FIG. 74.—ANKYLOSING ARTHRITIS, EXTREME TYPE, CAUSE UNKNOWN.

Photograph of vertical section through phalangeal joint. Shows the distal phalanx, 1, dislocated forward and downward into the palm of the hand; the joint cavity, 2, is practically obliterated and replaced by loose, dense, fibrous adhesions. The joint cartilage has entirely disappeared; the trabeculæ of the phalanges are less numerous and smaller than in normal bone.

it no longer is possible to distinguish from which of the original four layers any portion of the new joint surface was derived. As the same process takes place in both of the adjacent bones of the joint, the two articular surfaces of bone, instead of being covered with normal articular cartilage, may be covered by a layer of new tissue derived in the manner just described. The results of the approximation of two such surfaces vary in accordance with the character and origin of the new tissue, *i. e.*, may be fibrous, cartilaginous, or bony ankylosis. If synovial pannus predominates, the ankylosis usually is fibrous; if perichondrial prolifera-

tion predominates, cartilaginous or bony ankylosis may occur. In the cases of bony ankylosis the union may be so complete as to obliterate the original joint surfaces completely, and the two adjacent bones may

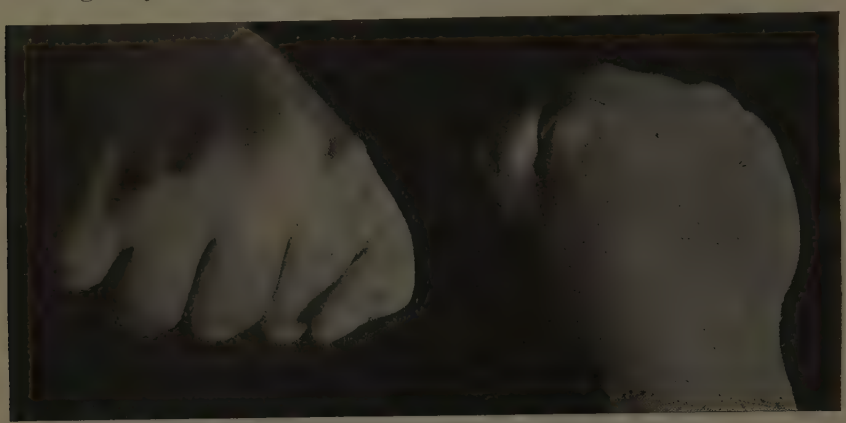

FIG. 75.—ANKYLOSING ARTHRITIS, EXTREME TYPE, CAUSE UNKNOWN.

Photograph of both hands. This case began insiduously and extended to practically every joint of the body, and lasted for over twenty years. There was practically no voluntary motion except slight motion of the thumb joint, also a slight amount of passive motion was possible. A pad had to be placed in the hand to keep the fingers from causing sloughs.

be united into one, with a perfectly continuous marrow canal. In most cases all four of these processes are present at the same time in one

FIG. 76.—ANKYLOSING ARTHRITIS, EXTREME TYPE, CAUSE UNKNOWN.

Photograph of both feet shows the extreme deformity of the toes due to dislocation of the metatarso-phalangeal joints. (Photographs from the same case as Fig. 75.)

joint, especially in the large joints, where "pannus," erosion of cartilage, either from above or below, with fibrous, cartilaginous, or bony ankylosis coexist in the same joint (Figs. 75–77).

Associated with these changes there is in many cases an apparent rarefaction of the bone in the vicinity of the affected joints; this is not an essential part of the original process, but usually is due to disuse of the joint. In nearly all cases there is a marked thickening of the

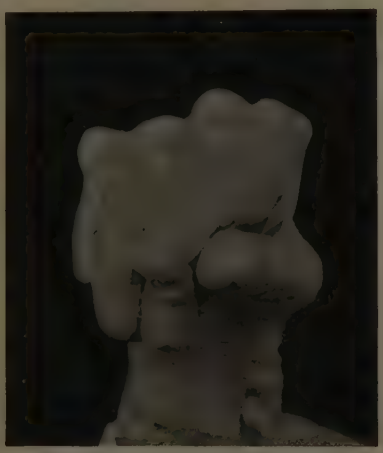

FIG. 77.—ANKYLOSING ARTHRITIS, EXTREME TYPE, CAUSE UNKNOWN.
From a woman of seventy-two, who for many years had been bedridden. The disease began insidiously in the large joints, and afterward involved most of the extremities.

joint capsule which may be extreme, especially in cases due to infection by the gonococcus. In some of these joints the proliferating synovial membrane may project into the joint cavity in the form of a

FIG. 78.—DEGENERATIVE ARTHRITIS, MODERATE DEGREE, CAUSE UNKNOWN.
Photomicrograph of section through a phalangeal joint and adjacent phalanges shows that the line of the joint cavity is very irregular. Areas of hyperplasia of the cartilage, 1, with, in other places, erosion of the cartilage down to eburnated bone of the opposing phalanx, 2. In other cases the cartilage shows fibrillation, 3. There was moderate thickening of the capsule. Also shows erosion of cartilage and eburnation of bone, with a compensatory overgrowth of opposing cartilage.

small papillary mass, the so-called "fungous joints," but this appearance practically never is extensive, nor is it as marked as it is in the degenerative joints, because, in the ankylosing joints, the tendency always is toward ankylosis and obliteration of the joint cavity. As a

result of destruction of joint cartilage and reflex spasm of the muscles, various luxations and dislocations of the joints may occur.

2. **Degenerative Arthritis.**—In joints of this type the primary change is a degeneration of the hyaline joint cartilage, as a result of which the cartilage becomes softened, fibrillated, and eroded, so that the underlying bone may become exposed. This degeneration of cartilage usually is at first confined to limited portions of the joint. Whenever erosion of the cartilage occurs in one facet of a joint, a corresponding overgrowth of the opposing joint surface occurs, thus leading to great irregularity of the cartilaginous surfaces. In course of time the newly formed cartilage may become converted into bone, and further erosion of both old and new cartilage may be so complete as to expose the underlying cancellous bone. In such cases the exposed bone becomes dense and "eburnated," so that in the end the joint surfaces, instead of being composed of two smooth articulating cartilaginous surfaces, are composed of irregular, hardened, bony surfaces. Since the degenerative changes take place gradually, motion in such joints is retained for a long time, and no true ankylosis ever occurs, but in rare cases motion is prevented by purely mechanical obstruction.

The process described leads to destruction of the joint. In addition to the attempt of repair by compensatory overgrowth of cartilage just mentioned, there is an attempt at repair, usually most marked at the periphery of the joint by proliferation of the perichondrium. This consists of the formation at the periphery of the articular surfaces of masses of cartilage, which later may become bone. Such changes are seen clinically most often in the fingers as " Heberden's nodes." This new deposit is *within* the joint capsule. By the deposit of this new peripheral bone within the capsule still greater irregularity of the joint is produced. As a result of the erosion and peripheral enlargement of the articular ends and of the distortion of the articular cavity, various subluxations or dislocations of the joint occur; in some cases a complete dislocation of the head of the bone occurs, and the deformed head lies in an entirely newly formed joint cavity at some distance from the original one. These dislocations are not, however, of sudden occurrence, but take place gradually under the influence of erosion and new formation of bone. In these cases, although joint motion may be much diminished, there is *no true ankylosis* of adjacent articular facets. In a very limited number of cases, because of the great erosion and irregularity of the joint facets, no motion may be possible, the so-called " ankylosis of deformity "; this is not a true ankylosis, but is merely a mechanical obstruction to motion.

The synovial new growths in these joints show no tendency to extend over or to destroy cartilage, as is the case in ankylosing joints, but may form numerous papillary growths into the cavity of the joint. These growths may be pedunculated or sessile; may be localized or general over the entire synovial membrane. These ingrowths may consist of granulation tissue, or may be fibrous tissue in which masses of cartilage or bone may form. These growths may project into and largely

fill up the joint cavity, and a joint filled with such masses is the so-called "polypoid" or "fungous joint." Some of these polypoid masses become detached from their pedicles and lie free in the joint, giving rise to free masses of granulation tissue, "rice bodies"; or free masses of cartilage or bone, "joint mice"; which, when caught between moving joint surfaces, cause serious interference with joint motion.

The *relation of clinical symptoms* to these two varieties of anatomic joint change is important. In the ankylosing type there is a primary proliferation of synovial membrane which tends to destroy the articular cartilage, to diminish the size of the joint cavity, and to lead to ankylosis, either fibrous, cartilaginous, or bony. The causes which produce this type of change are numerous; some are known, some may be merely inferred, and many are unknown. Joints of this type may be single, multiple, or general. The onset may be sudden or insidious. The changes usually are associated with severe pain, tenderness, thickening

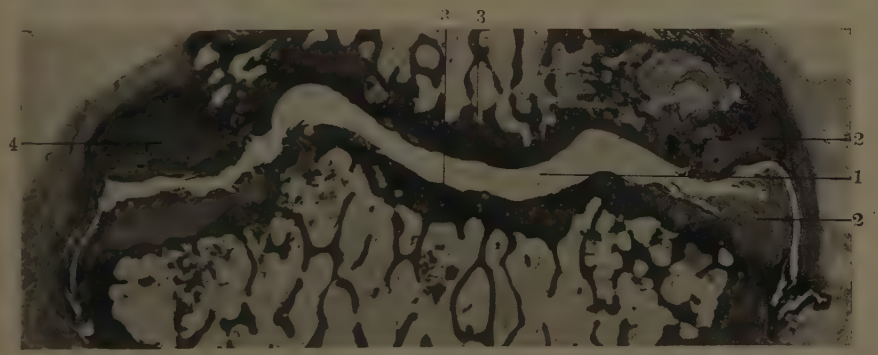

FIG. 79.—DEGENERATIVE ARTHRITIS, MODERATE DEGREE, CAUSE UNKNOWN.

Photomicrograph of the phalangeal joint and adjacent phalanges. The line of the joint cavity is very irregular, 1; the cartilage has been almost entirely destroyed and shows only at the margins of the joint, 2; the articular surface of the phalanges where the cartilage has been destroyed is eburnated, 3. There has been a new growth of bone at the periphery of the joint (beginning Heberden's node), 4. The erosion of cartilage and eburnation, in this case, effects both sides of the joint articular facets.

of the capsule, swelling, often fusiform, of the affected joints, and marked secondary diminution of lime salts in the adjacent epiphyseal bone ends, diminution of motion early, and, in the later stages, ankylosis of greater or less degree, with partial dislocation. The enlargement of the joint is due chiefly to thickening of the capsule. In many instances these changes are associated with disturbances of skin function and intestinal indigestion. Some are secondary to a primary bacterial infection, some are secondary to trauma, and some to faulty metabolism. The disease usually is progressive, advances by remissions, and, in most cases, leaves permanent diminution of joint function.

In the degenerative type the primary change is a degeneration of the joint cartilage, which may lead to its complete destruction; there is a compensatory growth of cartilage or bone on the articular end of one bone to compensate for the loss of cartilage on the other; as a result, great irregularity of the articular facets occurs, and great diminution of

joint motion may result from purely mechanical causes. There also occurs a new formation of cartilage and bone at the periphery of the joint which may lead to partial or complete dislocation, or even to the formation of a new articular cavity. There also is in these cases, notably in the large joints, a marked tendency to ingrowth of tags of synovial membrane, leading to "polypoid" joints, and such masses, when broken off, lead to the formation of foreign bodies which cause interference with joint function. Motion in these cases usually is long retained, and complete loss of motion when it occurs is due to mechanical obstruction and not to true ankylosis. The enlargement of the joint in these cases is due to bony new growth.

The causes which lead to these degenerative changes are numerous, but are not the same causes which lead to the ankylosing type, and in many cases can only be inferred, and in many other cases are unknown. These cases are insidious in onset, rarely are acute. Single or multiple joints may be affected. Often joint changes are recognized, notably in the hands, before any diminution of joint function is noted. The disease is progressive, and progress is by remissions, but the remissions are less marked than in the ankylosing type. Motion of some degree is usually retained even in the most seriously affected joints.

The aim of the clinician in these cases should be, first, to recognize the anatomic type of change present in a given joint; second, to determine the exciting cause in the given case. In some cases of both types the cause may then be removed and further progress of the disease may be checked. In most cases, unfortunately, the cause cannot be determined, and in such cases treatment must be guided by general principles, based upon a knowledge of the actual conditions present.

CHAPTER CI.

SURGERY OF THE JOINTS (CLINICAL PART).[1]

By Robert W. Lovett, M.D.,
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Chronic Synovitis.—A condition which often passes for chronic synovitis, especially of the knee-joint, is really the result of the muscular atrophy lasting over from acute synovitis, or is the result of the joint inflammation and the consequent disuse of the affected limb. In practice one of the commonest causes of prolonged irritability and insecurity in the knee-joint is to be found in the lack of tone and power in the muscles of the thigh. Along with this goes lateral mobility at the joint, and although the synovial membrane may be free from thickening, the knee tires quickly and is irritable and painful on use. The diagnosis of this condition is easily made by excluding the existence of synovitis and recognizing the slack condition of the muscles just above the knee. Such patients, as a rule, resort to elastic knee-caps, which tend to keep up and increase the muscular disability.

The treatment consists in supporting the knee temporarily by a bandage, prescribing gentle massage and resistive exercises, and after a few days insisting on the progressive use of the knee in walking.

Gonorrheal Arthritis.—The treatment of this form of arthritis by means of vaccines has received some attention, and its beneficial effects in many subacute cases have been noted. An autogenous vaccine is in many cases preferable to a stock vaccine. The favorable effect of this treatment in cases of long continuance is not generally evident. The use of passive hyperemia by Bier's method is sometimes of use in the treatment of this and in forms of chronic synovitis of other origin. The method is described under Tuberculosis of the Joints.

Arthritis Deformans.—The fact that many cases of arthritis deformans are apparently due to auto-intoxication of intestinal origin has been insisted on, and progress has been made in the relief of such cases by means of a diet low in proteins to reduce the nitrogenous fermentation in the intestines, and by the addition to the diet of some form of fermented milk. The presence of indol and skatol in the urine are suggestive of this absorption.

In such cases milk and the farinaceous foods represent the least putrefactive elements, and the addition of the lactic acid bacillus is found to check still further the tendency to fermentation. The diet, in cases where there is reason to suspect intestinal fermentation as a possible

[1] Supplementary to Chapter XXV., Vol. II., p. 282.

etiologic cause, should consist largely of farinaceous foods, with the free use of buttermilk, or naturally or artificially soured milk.[1]

Arthritis Deformans of Hip.—Treatment.—In arthritis deformans of the hip-joint an operation has been devised by Albee[2] as a substitute for excision, which has been followed by success in a number of reported cases. The capsule is exposed by an incision along the inner border of the sartorius muscle, and with a flat chisel the upper portion of the head of the femur is cut away in a line corresponding with the femoral neck, and with the chisel the upper part of the acetabulum is cut out so as to prevent a flat denuded bony surface for the correct apposition of the bony surfaces with the leg abducted. In this position a plaster-of-Paris spica bandage is applied from the toes to the axilla. The operation is also applicable in cases of flail hip-joints from paralysis.

Tuberculosis of Joints.—Diagnosis.—In the diagnosis of joint tuberculosis tuberculin may be used subcutaneously, in the eye or by the skin reaction, and is of use up to a certain point, but it must be remembered that there is always a possibility of error in the individual case. A child without joint tuberculosis may have a tuberculous focus elsewhere and give a positive reaction, while a patient with positive joint tuberculosis, as later proved by operation, may give a negative reaction to any one of the three methods. It must be remembered that certainty is obtainable only by inoculation experiments of the material from the joint or from microscopic examination of the tissue, and that the reactions mentioned can only be regarded as suggestive. The use of the opsonic index in the diagnosis of tuberculosis of the joints has proved to be attended by so large an error that its use as an exact diagnostic measure is open to the same criticism as that of the other methods mentioned above.

Serum Treatment.—No satisfactory evidence of the therapeutic value of the various serums containing tuberculin has as yet been brought forward to show that they are of any special value in the treatment of joint tuberculosis. Many enthusiastic articles extolling their value have appeared, but the general opinion of the men of largest experience is that their value is problematic, but that the use of tuberculin subcutaneously in minute doses is perhaps the most advisable if the treatment is to be used at all. One has only to contrast the point of view with regard to the therapeutic value of tuberculin to that of the outdoor treatment of the same class of cases, where there is universally expressed the opinion that this latter treatment is of the greatest possible value.

Treatment of Tuberculous Sinuses by Bismuth Paste.—The method of treatment of tuberculous sinuses by bismuth paste (a mixture of bismuth and vaselin), as advocated by Beck,[3] was widely adopted, and by some judged as efficient, while by others considered

[1] Combe, Intestinal Auto-intoxication, New York, 1908. Andrews and Hoke, Amer. Jour. Orth. Surg., 1907, vol. lxi.

[2] Jour. Amer. Med. Assoc., June 13, 1908; Zentralbl. Orth. Chir., Dresden, 1909, 564.

[3] Jour. Amer. Med. Assoc., March 14, 1908; Münch. med. Woch., 1910, No. 33.

dangerous or useless. Deaths have occurred with cases of severe poisoning from a proceding which appeared harmless.[1] In many cases the closure of sinuses apparently has been hastened by the method, but it cannot be considered as free from risk to life, and is in many cases of doubtful utility.[2] In acute cases Beck advises the use of a 10 per cent. paste used several times. If a 33 per cent. paste is used the mass of paste should be removed by means of suction as soon as the secretion becomes sterile.

Tuberculosis of the Hip. Correction by Osteotomy.—It should be mentioned that in the correction of deformity due to ankylosis in a faulty position, in addition to the subtrochanteric osteotomy

FIG. 80.—PHOTOGRAPH OF CASE OF COXA VALGA, SHOWING ABDUCTION, EXTERNALLY ROTATED FLEXED POSITION OF THIGH, WITH 1 INCH ACTUAL LENGTHENING, RIGHT SIDE. (Allison.)

the neck of the femur may be divided through an anterior incision, which has the advantage of correcting the deformity a little more accurately, but which necessitates rather a deep, extensive incision, and in which the bone division occurs nearer the cicatrized joint than in the other operation.

Coxa Vara.—Treatment.—In addition to the linear or wedge-shaped osteotomy, in which the femur is divided below the trochanter minor, it is possible through an anterior incision to divide the neck of the femur at the site of the deformity, and by abducting the leg after division to correct the vicious angle, after which, as in the older form

[1] Matsnoka, Deutsch. Zeits. Chir., 102, iv.–vi., 508.
[2] Ridlon and Blanchard, Amer. Jour. Orth. Surg., 1909, vii., 1.

of osteotomy, a plaster-of-Paris spica bandage is applied with the leg abducted.

Coxa valga, which is a recently described affection, is now more frequently recognized than was the case some years ago, and several traumatic cases have been recorded.[1] A wider range of operative treatment has been followed, and osteotomies, both of the neck of the femur and below the trochanter, with subsequent adduction of the leg, have been successfully performed. Improvement also has been reported from the retention of the affected leg in a position of forced adduction by means of a plaster-of-Paris spica bandage.

The matter of various approaches to the hip-joint for the preceding operations and other similar ones have been recently discussed.[2]

A B

FIG. 81.—RADIOGRAMS OF AFFECTED AND UNAFFECTED SIDES IN A CASE OF A VERY PAINFUL SWELLING OF THE TUBEROSITY OF THE TIBIA ON THE RIGHT SIDE (A), WITH NO PAIN ON THE LEFT (B), CHILD OF TWELVE.

Disturbances of Epiphyseal Growth (Apophysitis).—In the case of growing and partially consolidated epiphyses, pain, swelling, and tenderness occasionally occur in children of ten and upward. The phenomenon is most often noted in the region of the tubercle of the tibia and in the epiphysis at the posterior end of the os calcis.

Tuberosity of the Tibia (Schlatter's Disease).—Enlargement and tenderness of this region have long been familiar to orthopedic

[1] Allison, Amer. Jour. Orth. Surg., v., 228; Kumaris, Arch. f. klin. Chir., 1908, 625. [2] E. G. Brackett, Boston Med. and Surg. Jour., Feb. 15, 1912.

surgeons, and are sometimes spoken of in recent literature as "Schlatter's disease."[1] Much has been written as to whether the symptoms are due to a traumatic avulsion of the tubercle or are incident to growth.

The tubercle of the tibia appears as a separate center of ossification, and develops into a tongue of bony tissue which consolidates with the tibia in late puberty. It frequently happens that children from twelve to fourteen complain of pain in this region, especially on active extenison of the leg, and a tender enlargement of the tubercle is found. A distinct traumatic history may be absent or present, but the tongue-like process is obviously subject to strain in knee extension from its function as the point of attachment of the extensor thigh muscle, so that it does not seem necessary in all cases to expect a definite history of accident. The *x*-ray shows in such cases a partially consolidated epiphysis, but on comparing the two sides, signs of avulsion of the tubercle are generally absent. In the severer cases some proliferation of bone is to be seen at the front of the affected epiphysis. Clinically, many cases develop tenderness in the other knee before the one first affected has recovered.

The diagnosis is made by recognizing a limited local tender swelling over the tuberosity, joint effusion is not present, and full active extension of the leg at the knee is likely to be painful. *x*-ray appearances are not distinctive, although the line of ossification may be a little more ragged on the affected side. Avulsion of the tubercle on the affected side should not be inferred from an *x*-ray without a radiogram of both knees and a comparison of them.

Whether the lesion is due to one definite accident or to strain coming upon a growing epiphysis seems a matter of no great importance.[2]

The prognosis is good, but progress is slow, and the nearer to consolidation the tongue-like process is, as seen in the *x*-ray, the shorter will be the duration. Treatment during the acute stage consists of fixation, and when the tenderness diminishes, in a restriction of activity, especially in stair-climbing and running.

Os Calcis (Pain in).—A similar condition, but in younger children, as a rule, exists at times at the posterior part of the heel, where a similar epiphyseal consolidation is taking place. It is of long duration, it may be unilateral or bilateral, and often occasions temporary lameness. Discomfort may be relieved in a measure by raising the heels of the shoes and removing the stiff counter at the back of the shoe.

Snapping Hip (*German, Schnappende Hüfte*).—A condition of no great rarity, characterized by a slipping around the hip-joint with sometimes an audible snap, occurring in the flexion and extension of the hip, has received attention of late. The condition is apparently, in one class of cases, natural to the individual, the snapping can be produced at will, and is painless, while in a second class it results from trauma, and is painful. The common cause of the snapping appears to be found in the slipping of a tendinous band (generally the iliotibial band) over the great

[1] B. Schlatter, Beitr. z. klin. Chir., 59.

[2] Haglund, Zeit. Orth. Chir., xxv., 649. Dunlop, Amer. Jour. Orth. Surg., Feb., 1912.

trochanter.[1] Operative measures have consisted in stitching the obstructing band (in this case the anterior edge of the gluteus) to the tendinous insertion of the vastus externus and the neighboring periosteum, by uniting the iliotibial band to the femur behind the trochanter, and by sewing the posterior edge of the band to the gluteus maximus. All of these procedures were followed by relief.

In another class of cases less commonly seen the snapping seems to be due to a deficiency in the posterior border of the acetabulum[2] (Braun and Gangele), and is more like a real subluxation than is the other type. If the posterior wall of the acetabulum is present in part, it is possible by means of chiseling to raise a rim of bone and periosteum to serve as a posterior border to the joint cavity.

Arthroplasty.—The technic of arthroplasty has been of late enlarged, and although the difficulties remain of securing motion in many stiff joints, a larger amount of success attends the operation than at first. The technic of the insertion of flaps of fascia or fat remains largely unchanged, and the progress of cases operated on by this method is more or less painful from the pressure on nerve-filaments in the interposed tissue. Most foreign substances when introduced have proved unsatisfactory, but the use of chromicized pig's bladder, as devised by Baer,[3] has been attended by a fair amount of success. The membrane is prepared by boiling it in cumol, and it is chromicized so as to remain intact for forty days. The membrane is placed so as to cover the denuded ends of the bones and is fastened with sutures. The introduction of so much foreign material is, as in all such instances, an obstacle to primary healing, but union by first intention should be secured. After tuberculous disease no operation should be undertaken until the process is thoroughly healed.

Lexer has tranplanted successfully from one patient to another in some instances half of a joint, or both epiphyses with their cartilages. Of course, the proceeding implies an amputation on a patient from whom the material is to be obtained. In 2 of Lexer's[4] cases this was done for gangrene, in others the amputation was for trauma. The bones to be transplanted should be divided transversely, and intra-articular ligaments and cartilage should be left intact, the new joint being held in place by skewers of fresh bone. Muscle plastic operations are generally necessary later for proper function. Movement is permitted only after the *x*-ray shows a good callus. The motion in several patients was recorded as from fair to good, but the operation cannot yet be regarded as a well-established procedure.

[1] Holman, Zeit. Orth. Chir., xxiv., 1, 2. Zur Verth, Deutsch. Zeit. f. Chir., 98, i., 47.
[2] Gangele, Zeit. Orth. Chir., xxvii., 279.
[3] Amer. Jour. Orth. Surg., 1909, vii., 1.
[4] Archiv. klin. Chir., ii., 90. Paye, Münch. med. Woch., 1910, 37.

CHAPTER CII.

DISLOCATIONS.[1]

By Daniel N. Eisendrath, M.D.,

Chicago.

CENTRAL DISLOCATION OF THE HIP.

The first writer to describe this form of injury was Callisen in 1788. During the nineteenth century the earliest descriptions are those of Sir Astley Cooper, and these were followed by a number of cases reported by French and German surgeons. Much confusion has existed as to the nomenclature and exact definition of the injury. The most accurately descriptive title is that employed by English surgeons—displacement of the head of the femur through the acetabulum into the pelvis. The title which was first suggested by German surgeons and which has been generally adopted is "central dislocation of the hip." If one accepts this name, cases of acetabular fractures of all varieties must be excluded, unless they are accompanied by a displacement through the acetabulum of either the entire head of the femur or at least of its greatest circumference.

Arreger[2] has collected 22 cases, published up to 1904, and added a case observed at the Lucerne Hospital. Since this publication a number of others have appeared. W. Simon[3] collected all of the cases up to 1907. Schroeder[4] has collected about 50 cases, including 3 of his own. Only a small proportion of the cases were true central dislocations, many being pelvic-ring fractures, which caused dislocation of the head of the femur only by virtue of large sections of the pelvic bones giving way. Fuller[5] has given a thorough résumé of the subject in a recent article, and added 2 cases of true central hip dislocation. Two of the most exhaustive articles of recent date are those of Woener[6] and Henschen.[7] The latter has only been able to find 16 cases, excluding his own, of genuine central dislocation, the remaining reported cases being classified as either doubtful or as cases of pelvic-ring fracture, in which the bony gap permitted the head to be displaced inward. Henschen's true cases do not include Schroeder's and Fuller's cases.

Through the more general employment of radiographic examinations this form of fracture-dislocation is no longer a curiosity, but is of

[1] Supplementary to Chapter XXVI., Vol. II., p. 377.
[2] Deut. Zeit. Chir., vol. lxxi.
[3] Beiträge klin. Chir., vol. xlv.
[4] Northwestern Univ. Med. Bull., June, 1909.
[5] Amer. Med. Jour. Sci., March, 1911, p. 385.
[6] Beiträge klin. Chir., vol. l. [7] Ibid., vol. lxii.

considerable clinical and forensic importance. The condition may result from one of a number of different causes. The most frequent mode of occurrence is as the result of a fall or a blow over the greater trochanter, especially when the direction of the force is parallel to the long axis of the head and neck of the femur. Other causes are falls upon the feet, blow over the opposite shoulder, blow over one or both tuberosities of the ischium or over the coccyx. The injury occurs most often between the tenth and thirtieth year.

Classification.—The division given in Henschen's article seems to be the most complete. He distinguishes:

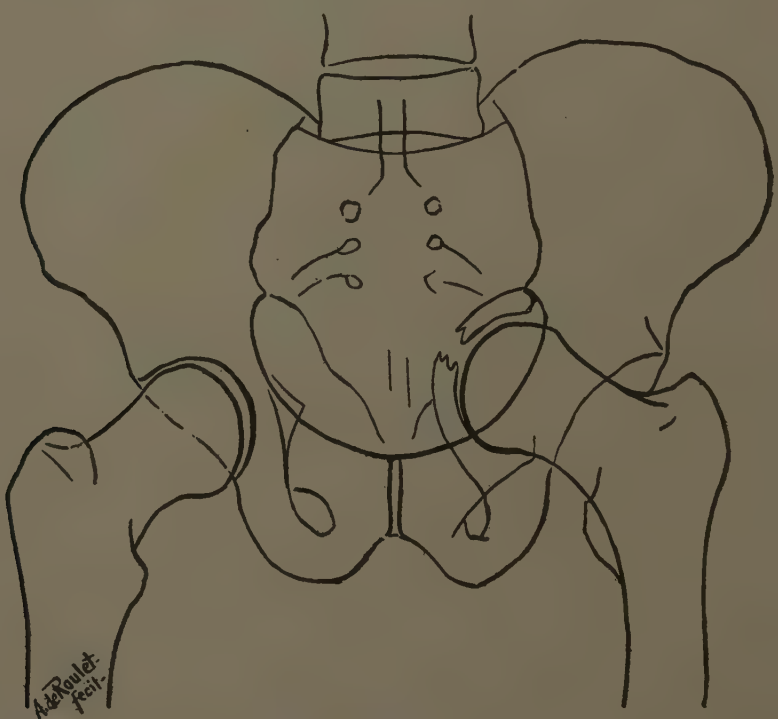

FIG. 82.—DIAGRAM TO ILLUSTRATE CONDITIONS FOUND IN CENTRAL DISLOCATION OF HIP.

(1) *Central Acetabular Fractures.*—(*a*) Simple fractures, usually radiating from the center of the acetabulum, or Y-shaped. In this variety there is usually but little gaping of the fissure.

(*b*) An advanced stage of (*a*). In this the acetabulum is broken, and the fragments depressed inward in such a manner that the head is more or less engaged in the opening. This has been termed central subluxation of the femoral head.

(*c*) The true central dislocation. This is a progressive stage of (*b*), the acetabulum being completely depressed, so that the head is pushed, either completely or at least by its greatest circumference, through the opening into the true pelvis (Fig. 82).

(2) *Excentric Acetabular Fractures.*—The force strikes away from the center of the acetabulum, and usually causes a triangular fragment to be broken off. According to the direction in which the triangle points, one can distinguish two varieties: (*a*) excentric fractures, with an inferior fragment, and (*b*) the same, with a superior fragment. In these cases the head of the bone remains in the acetabulum.

(3) *Complete Separation (Ring-like) of the Acetabulum.*—Vaquez has described such a case in which the head of the femur remained in articulation with the acetabulum, but both were displaced completely inward. Although there was a displacement of both inward, the case does not belong to the true central dislocations because the acetabulum itself was not fractured.

FIG. 83.—WASH DRAWING MADE FROM X-RAY OF DR. HELIODORE SCHILLER'S CASE OF CENTRAL DISLOCATION OF HIP.
Note how head of femur pushes acetabulum inward.

(4) *Combined Acetabular and Pelvic-ring Fractures.*—This class includes all cases in which, in addition to the fracture of the acetabulum, there are independent fractures of the pelvic bones or separation of the pubic symphysis or of the sacro-iliac synchondrosis.

Symptoms.—Clinically, one encounters this injury in two different forms. The first clinical group includes the typic acetabular fractures, in which the femoral head has been pushed a variable distance into or through the funnel formed by the acetabular fragments. The symptoms of this injury are:

(1) Depression over the trochanteric region, varying according to the extent to which the head has been pushed through the acetabulum. The trochanter lies nearer to the median line upon the injured than upon the uninjured side.

(2) Deep-seated pain in the hip upon pressure over the trochanter, or on tapping the heel or in rotating the limb.

(3) Very little or no shortening.

(4) Internal rotation is greatly decreased and is very painful.

(5) Upon rectal examination one finds, upon sweeping the finger over the pelvic wall, that there is a fixed pain, sharply localized over the inner side of the acetabulum, upon the side of the injury. It is wise to compare this finding with a similar palpation of the opposite side of the pelvis. In some cases a convex projection, or even crepitating fragments, have been felt over the acetabulum.

(6) *X-ray Pictures.*—This is the most accurate means of diagnosis (Fig. 83), and should be employed in all cases of injury of the hip. Many old cases of such injury may thus be recognized as due to acetabular fractures, with or without dislocation inward of the femoral head.

The second clinical group of cases is that which has been more familiar to the surgeon. This second group includes all fractures of the acetabulum proper or acetabular-ring fractures, with dislocation of the head inward. The triad of physical signs which are characteristic of this group are: (*a*) Eversion of the limb, which can be easily corrected, but which readily recurs; (*b*) the trochanter lies nearer to the median line; (*c*) the femoral head and the fragments can be felt through the rectum on the inner side of the acetabulum. (*d*) Add to these an *x*-ray picture.

It will be seen from the above that the first group represents the incomplete stage, and the second group includes the complete stage of dislocation of the femoral head inward through the fractured acetabulum.

A pathognomonic symptom, when present, is pain along the course of the obturator nerve. This neuralgia may be only transitory, being relieved as soon as the fracture has been corrected, or it may remain as a permanent condition if the nerve is caught in the callus.

In some of the recent cases, especially those of Schloffer, Simon, and Henschen, it has become evident that an interval may occur between the time when the fracture takes place and the dislocation inward of the femoral head follows. An effort has been made to divide the cases into primary central dislocations, the acetabular fracture and displacement inward of the head occurring at the time of the first injury; and secondary cases, in which there is first a fracture of the acetabulum, and later a pushing inward of the femoral head. In Henschen's case the interval was five to six weeks.

Complications and Sequelæ of Central Dislocations.—Among the most frequent complications are: (*a*) Ruptures of the ileopsoas or obturator muscles, with the formation of enormous subperitoneal hematomata, which may extend upward to the kidney and compress the bladder. These hematomata show a great tendency to suppuration; (*b*) primary and secondary nerve injuries (obturator and sciatic); (*c*) vascular injuries; (*d*) rupture of the bladder, usually as the result of an accompanying pelvic-ring fracture. Among the sequelæ the most

important are: (*a*) An arthritis of the hip-joint, with varying degrees of interference of motion and at times resulting in ankylosis; (*b*) dystocia. A number of cases have been reported of marked interference with the normal course of labor.

Treatment.—The cases in which the displacement inward of the femoral head occurred as a secondary factor teach us that the injury must be regarded as very serious, and that too much care cannot be exercised in guarding against walking upon the injured limb too early. The two chief objects of the various methods of treatment are to push the femoral head from the true pelvis, and to keep it in its normal relation after correcting the deformity. The first object is best attained by flexing the thigh and adducting the limb forcibly, while the inner side of the thigh rests on a sand-bag and the pelvis is held rigid. In this manner the femoral head can be lifted out of the pelvis. One should never attempt to correct the deformity by inserting the finger into the rectum and pushing the femoral head outward. The degree, however, to which the displacement inward has been corrected can be best judged by a rectal examination. The amount of force required to replace the head in a recent injury is relatively slight. The second object, keeping the head in its corrected position, is best attained by making extension while the limb is kept adducted and flexed at the thigh and knee.

Early massage and passive motion (from the second week on) must not be omitted. The limb should be kept suspended for at least six weeks, and no walking allowed for some weeks later (eight to twelve weeks).

CHAPTER CIII.

SURGERY OF THE MUSCLES, TENDONS, AND BURSÆ.[1]

By John Fairbairn Binnie, M. D.,

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BURSITIS.

Codman believes that *subacromial bursitis* is the most common form of bursitis, but that it is frequently not recognized, being diagnosed as "brachial neuritis, periarthritis, muscular rheumatism, circumflex paralysis, contusion of the shoulder, fibrous ankylosis, gout, rheumatism, and other vague terms." The causes of the bursitis are numerous, but trauma is probably the most common. Clinically, Codman divided the lesions into the following types: (1) Acute or spasmodic; (2) subacute or adherent; (3) chronic or non-adherent.

In all these types there is pain, located commonly at the insertion of the deltoid, and especially severe at night. When adhesions are present abduction beyond 10 degrees is impossible. When adhesions are absent abduction and external rotation may be limited or prevented by muscular spasm and pain. Sometimes roughness of the bursal lining momentarily impedes motion, but continued effort overcomes the impediment with a jerk, as in "trigger-finger." Even under careful treatment disability often persists for months or even several years, yet the prognosis is good. Treatment consists in rest with the arm abducted until acute symptoms have disappeared. This rest must not be too absolute and not too prolonged, lest adhesions form. Later, motion must alternate with rest. In severe and persistent disease it is wise to excise the accessible portions of the bursa.

Supraspinatus Tendon.—The deltoid muscle only acts as an abductor of the arm after the great tuberosity of the humerus has been pulled under the acromion and the humerus partly abducted by the supraspinatus.

If the deltoid contracts powerfully, and if, for any reason, the supraspinatus has failed to act, then the tuberosity of the humerus does not slide under the acromion, but is forced against it, and thus the tendon of the supraspinatus becomes pinched between these two bones and may be partially ruptured. According to Codman this accident is very common and gives rise to symptoms of, if it does not actually occasion, *subacromial bursitis*. In 3 patients Codman has found complete rupture of the supraspinatus tendon, causing symptoms of "adherent sub-

[1] Supplementary to Chapter XXVII., Vol. II., p. 435.

acromial bursitis." In 2 of these 3 cases Codman operated, repairing the tendon with good result.

Subacromial or Subdeltoid Bursitis.—The supraspinatus muscle passes over the shoulder-joint, to be inserted in the great tuberosity.

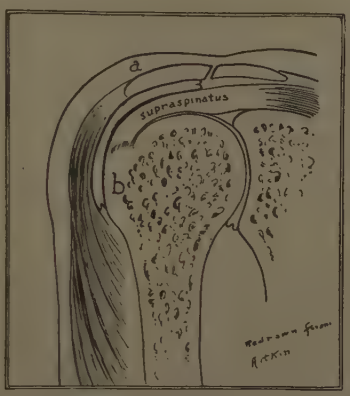

FIG. 84.—DIAGRAM FROM FROZEN SECTION. (E. A. Codman.)

Notice the deltoid and its origin from the edge of the acromion. Notice the subdeltoid or subacromial bursa with its roof made by the under surface of the acromion and by the fascia beneath the upper portion of the deltoid. Its base is on the greater tuberosity and the tendon of the supraspinatus, which separates it like an interarticular fibrocartilage from the true joint.

In action this muscle abducts the shoulder and pulls the great tuberosity under the acromion process. The deltoid when acting alone pulls the humerus upward against the acromion, but when it acts in conjunction with the supraspinatus it acts as a very powerful abductor. The sub-

FIG. 85.—ILLUSTRATING THE CONDITION WHICH WOULD BE FOUND IN ABDUCTION, THE TUBEROSITY HAVING PASSED UNDER THE ACROMION AND THE POINT (*b*) HAVING PASSED THE POINT (*a*). (E. A. Codman.)

The elastic deltoid has taken up the slack at one end and the supraspinatus at the other. It is obvious that the floor of the bursa, as it lies on the tendon of the supraspinatus and the tuberosity, must be a smooth, even, round surface. As a matter of fact, the first time one cuts into the bursa one is almost startled to find how much the floor of it looks like the cartilaginous surface of the bone. It is obvious that if the surfaces of the bursa between the points *a* and *b* in Fig. 84 were adherent, it would be impossible for the joint to pass into the position shown in Fig. 85.

acromial bursa exists between the supraspinatus below and the deltoid and acromion process above. The base of the bursa at its outer end is firmly attached to the tuberosity of the humerus and to the tendinous expansion of the supraspinatus. The roof of the bursa at its inner part is firmly attached to the under surface of the acromion and the

coraco-acromial ligament. The rest of the wall of the bursa is very loosely attached to its surroundings. The anatomic peculiarities make it so that when the arm is abducted the fixed floor of the bursa (Fig. 84, *b*) is carried under the acromion and the roof of the bursa (between Figs. 84, 85, *a*, *b*) is rolled up in the same direction, so that part of it takes the position of the floor of the bursa. A proper appreciation of this normal sliding or rolling of the bursa is of great importance, as anything which interferes with it causes much disability. In acute bursitis, when the arm hangs by the side, palpation over the bursa just below the acromion to the outer side of the bicipital groove causes pain, but in some cases when the arm is abducted this point of tenderness disappears (Dawbarn's sign) because the tender bursa has passed up under the acromion out of reach of the palpating finger.

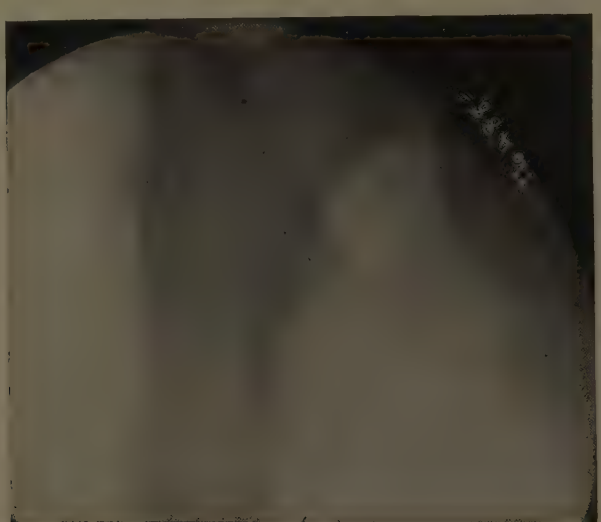

FIG. 86.—DEPRESSION ON SURFACE OF GREAT TROCHANTER CAUSED BY AN ENLARGED BURSA.

Bursitis occurring in the **neighborhood of the hip** may give rise to very puzzling conditions. A lady suffered for over twenty years from a varying amount of disability due to pain about the hip. Treatment by rest, exercise, drugs, etc., failed. There was an indefinite swelling over the great trochanter, and a skiagram showed a corresponding depression of the bone. On operation a small but thick-walled bursa was found between the tendon of the gluteus medius and the trochanter major. Excision of the bursa resulted in prompt cure (Fig. 86).

It is more common to find involvement of the gluteal bursa which lies between the tendon of the gluteus maximus and the great trochanter. Inflammation of a bursa (iliac bursa) lying between the iliopsoas muscle and the pelvis external to the pectineal eminence is often mistaken for coxitis. As the bursa communicates with the hip-joint in about 10 per cent. of adults, coxitis and bursitis may coexist. Differ-

ential diagnosis between iliac bursitis and coxitis must be based on the fact that in the bursitis there is no shortening of the limb and that "the patient may often walk and bear weight upon the limb without discomfort" (Johnson). Very large cystic tumors may result from disease of the iliac bursa.

Cullen[1] describes such a tumor which communicated with the hip-joint and extended up under Poupart's ligament into the abdomen (Fig. 87). The tumor contained several large free cartilaginous masses.

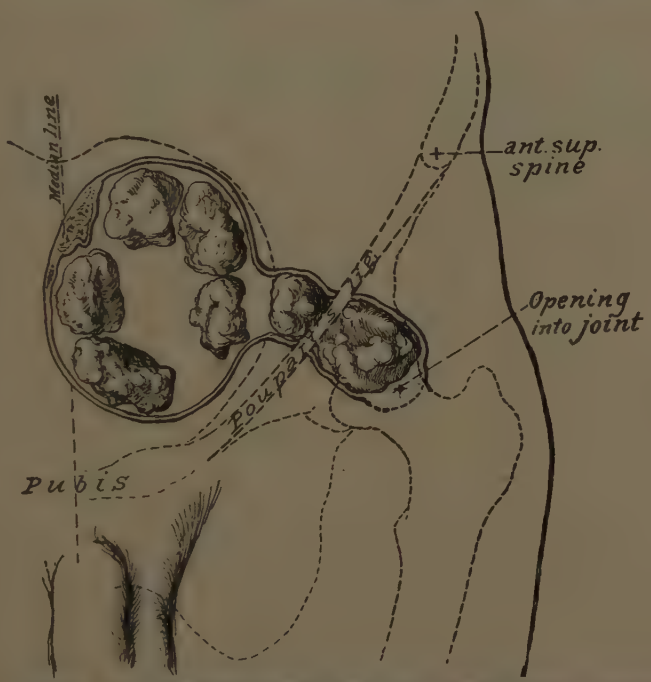

FIG. 87.—A CYSTIC TUMOR DEVELOPING FROM THE LEFT ILIOPSOAS BURSA CONTAINING LARGE FREE CARTILAGINOUS MASSES AND COMMUNICATING WITH THE HIP-JOINT. (Cullen.)

Occupying the left half of the pelvis is a cystic tumor which on its outer side was firmly attached to the pelvic wall. The cyst walls were composed chiefly of fibrous tissue. The thickening in certain areas noted in the walls is due to deposits of bone. The cyst-cavity was distended with clear yellowish, tenacious fluid and also contained fine free and irregular cartilaginous masses. A narrow prolongation of the cyst passed downward and forward beneath Poupart's ligament and opened directly into the hip-joint. Filling this portion of the cyst was a large free cartilaginous mass.

The *bursa*, lying between the *semimembranous expansion* and the inner head of the *gastrocnemius*, usually communicates with the knee-joint. It is difficult to determine in individual cases whether disease of the bursa is primary or secondary to an arthritis. Barker[2] inclines to the belief that the bursitis is often primary and the coexisting arthritis secondary.

Barker writes: "The effect of this distention is to produce an aching pain with a sense of weakness in the joint. The swelling can

[1] Jour. Amer. Med. Assoc., April 9, 1910.
[2] Brit. Med. Jour., June 3, 1911.

usually be recognized when the limb is fully extended as an ill-defined elastic mass, almost directly behind the knee, which is soft during flexion and tense during extension. As this bursa usually communicates with the knee-joint, its contents in slight flexion can sometimes be squeezed into it when abundant, and can be felt to distend the synovial pouches of the knee. When small, this cannot be felt, but in advanced cases it is quite demonstrable. In very extreme forms the knee-joint is also much distended with fluid, which can be made to fluctuate easily from the joint to the bursal sac and *vice versâ*.

"In such cases the bursal sac may be enormously distended and reach far down the leg. In a case recently under my care it reached half-way down to the ankle, and at the same time the knee-joint was hugely distended in all directions, the fluid passing easily into the bursa on pressure and back again into the knee. In another, operated on recently in private, the same conditions were present, though to a smaller extent. In both of these cases the diseased process appeared from the history to have started in the bursa and furnished fluid to the joint, and not conversely."

CHAPTER CIV.

ORTHOPEDIC SURGERY.[1]

By Robert W. Lovett, M.D.,

Boston.

POTT'S DISEASE.

In the treatment of Pott's disease an advance has been made by Calot, who has described a method of applying jackets which in accuracy and efficiency is superior to those formerly used. The patient is sus-

Fig. 88.—Application of Posterior Sheets. (Calot.)

pended by the head and the jacket applied not by bandages, but by sheets of crinolin cut in a special pattern, which are impregnated with plaster of Paris and water. These sheets are molded to the body by

[1] Supplementary to Chapter XXVIII., Vol. II., p. 469.

turns of the ordinary plaster bandage. In all cases they embrace the shoulders, and in disease above the mid-dorsal region they are carried up under the chin and occiput. A square window is then cut out over

Fig. 89.—Modeling the Apparatus Above the Iliac Crest. (Calot.)

the kyphus, and layers of absorbent cotton are placed under the piece cut out, which is then reapplied and held in place by plaster bandages. A large triangular window is then cut out in front opposite the kyphus.

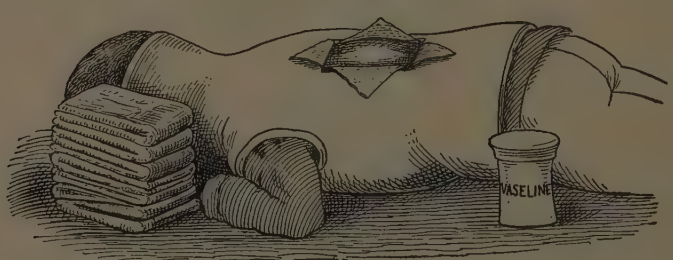

Fig. 90.—Dorsal Window for Compression. (Calot.)

By successive layers of padding placed over the kyphus at intervals of a week or so a constant forward pressure is kept up on the dis-

eased part of the spine. The patient is kept for some months recumbent, and successive jackets applied as necessary. Under these conditions it is reasonable to expect some permanent recession of the deformity.[1]

This combination of a well-fitting jacket, exercising continually increasing pressure, with recumbency, seems to offer the best treatment at our command at present.

Attempts to stiffen the affected region of the spine by bone plastic operations[2] on the posterior part of the column, and by the insertion

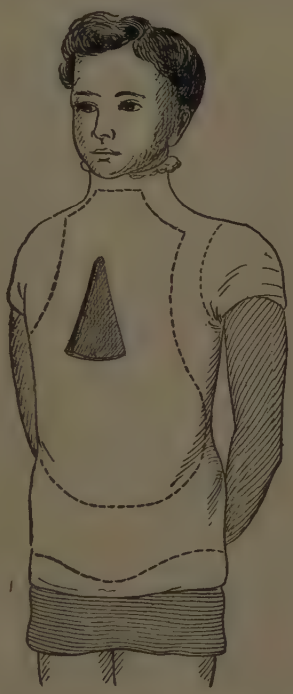

FIG. 91.—FINISHED APPARATUS WITH MILITARY COLLAR. (Calot.)

of metal rods wired to the vertebræ,[3] have not yet been definitely accepted by orthopedic surgeons, although on trial and apparently likely to be useful.

TREATMENT OF STRUCTURAL LATERAL CURVATURE.

The tendency in the treatment of structural lateral curvature of moderate and severe grade is toward the use of more continuous and effective force than formerly. Structural cases of slight degree may be treated by gymnastics, exercises in apparatus designed for the purpose, and passive stretching, as mentioned in the former edition, but this treatment should be pursued only so long as the cases continuously improve.

[1] Calot, Orth. Indispensable, Paris, 1909.
[2] Albee, N. Y. Med. Jour., March 9, 1912. Hibbs, Annals of Surg., May, 1912.
[3] F. Lange, Amer. Jour. Orth. Surg., viii., 1, 344.

Cases of more than a slight degree, that is, cases to be classed as of moderate and severe grades, should be attacked at the outset as bone rather than muscle problems, and an attempt should be made to force the vertebræ back into an improved position by the use of continuous force by means of corrective jackets worn over long periods. In this way it is possible to influence bony growth in the direction of improving the deformity.

Such treatment may be carried out in one of two ways: (*a*) The patient is suspended or laid prone on the face or on the back, and a corrective plaster jacket applied. This jacket is then cut away over the back on the side opposite to the curve, leaving the top edge in place, and

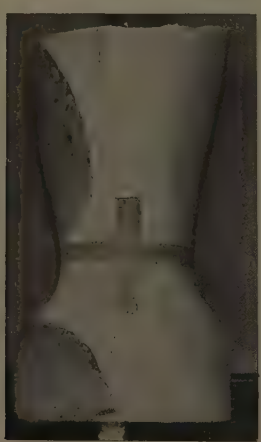

FIG. 92.—REMODELED TORSO READY FOR APPLICATION OF JACKET IN A CASE OF RIGHT DORSAL LEFT LUMBAR SCLEROSIS, WHICH HAS BEEN CUT IN TWO AT THE WAIST AND SET APART 1 INCH, SO AS TO INCREASE THE UPWARD PRESSURE ON THE RIBS. (Lovett and Sever, Jour. Amer. Med. Assoc.)

The dark areas on left of the torso show where plaster has been added on the concave side to allow for correction of displacement and deviation.

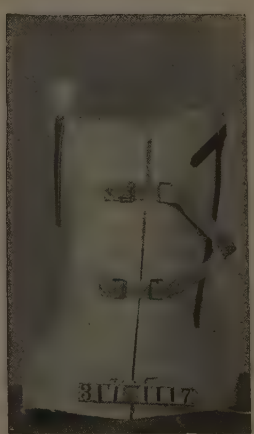

FIG. 93.—FRONT OF JACKET MADE OVER TORSO SHOWN IN FIGURE 92. (Lovett and Sever, Jour. Amer. Med. Assoc.)

Note shoulder pad.

in front a similar square opening is cut diagonally opposite the opening in the back. Where the jacket is left solid in the back, over the rotated and curved portion of the spine, it is padded by layers of felt passed in through the openings so as to exercise pressure on the curved region, and this padding is added to each week or two. Every two or three months the jacket is changed and made more effective, and the padding again begun. After a variable period a great change should have been effected in the spine, and a removable jacket (made as will be described) substituted and exercises begun, lasting over a period of months, during which the jacket is gradually omitted. Muscular atrophy is marked on first removing the permanent jacket, but the muscles soon recover their tone under massage and exercise.

(*b*) By the second method one, two, or three forcible jackets are applied to the patient for a week each, and then the patient is suspended and a snug plaster jacket applied. This is cut off and filled with

plaster of Paris and water. The torso thus obtained is then trimmed and filled out to represent an improved condition of the patient, and to this torso is applied a plaster jacket, which is split and removed and furnished with buckles and straps. This jacket is then worn by the patient day and night, and only removed for exercises, which are done daily. The sides of the removable jacket may be cut out and padding

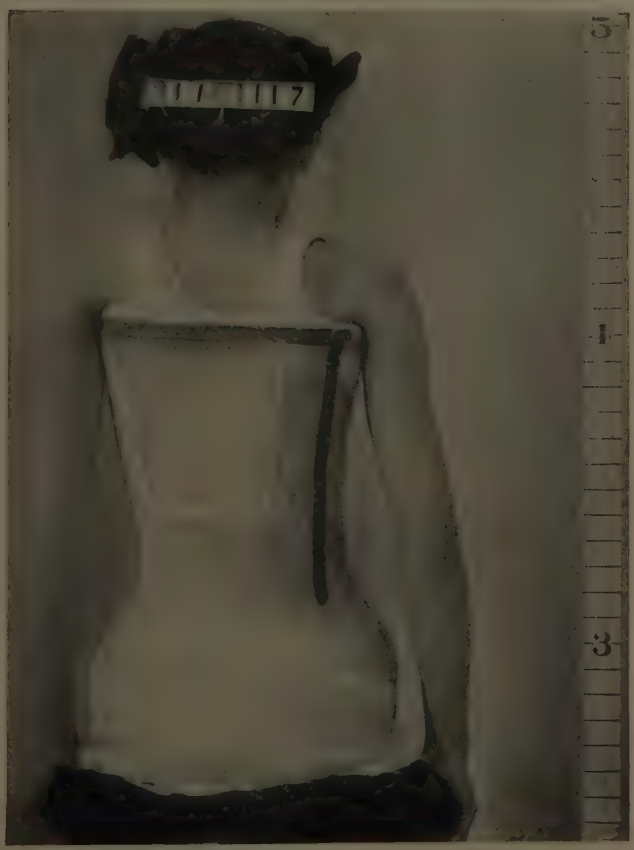

FIG. 94.—PATIENT IN JACKET SHOWN IN FIGURE 93. (Lovett and Sever, Jour. Amer. Med. Assoc.) Note window on concave side. Jacket reinforced by steel strips.

used if desired in the same way as described for permanent jackets. Treatment by permanent jackets is best suited for hospital cases, and treatment by removable jackets is best adapted to the class of private patients who are under effective control.[1]

REFERENCE.

Congenital Elevation of Scapula (Sprengel's Deformity).
Horwitz: Amer. Jour. Orth. Surg., vi., 260.

[1] Lovett and Sever, Jour. Amer. Med. Assoc., Sept. 2, 1911.

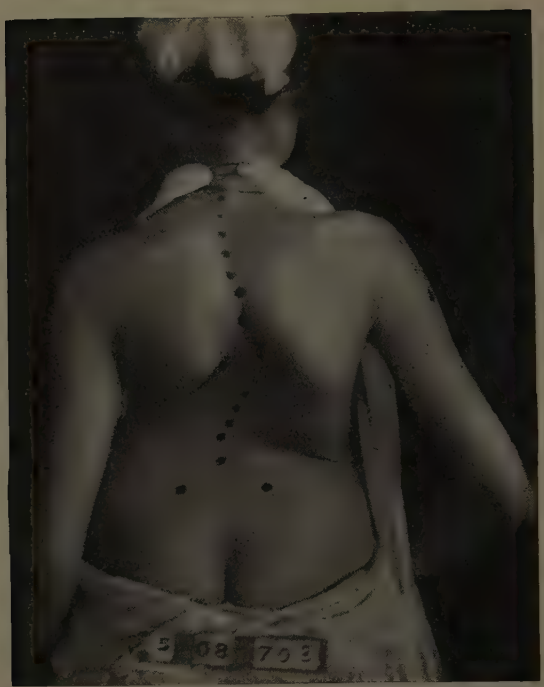

FIG. 95.—GIRL AGED SIXTEEN, BEFORE TREATMENT. (Lovett and Sever, Jour. Amer. Med. Assoc.)

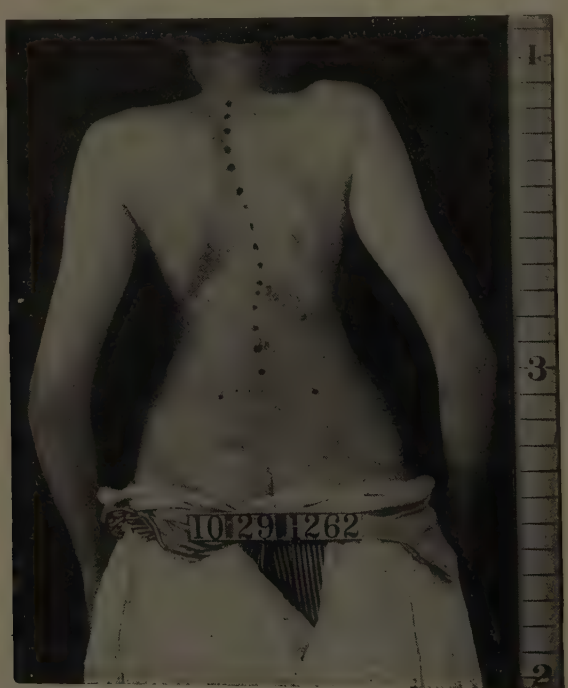

FIG. 96.—GIRL AGED EIGHTEEN, AFTER TWO AND ONE-HALF YEARS' TREATMENT BY MEANS OF A SERIES OF PERMANENT JACKETS. (Lovett and Sever, Jour. Amer. Med. Assoc.)

INFANTILE PARALYSIS.

(*Newer Synonyms.*—Poliomyelo-encephalitis, the Heine-Medin Disease.)

The very great increase of infantile paralysis since 1907 in certain parts of the world, notably in the United States, has led to a better clinical and pathologic knowledge of the disease from the opportunities for study thus afforded, and the treatment has become more precise and defined. Prior to 1904 in the United States an average of about 15 cases per year were reported. In 1910 nearly 9000 cases were reported in the 43 states. A similar increase has not occurred in Europe. The disease has been proved to be infectious, and can be reproduced experimentally by inoculation into monkeys. The organism causing it belongs to the so-called "filterable" viruses, and cannot be seen by the microscope. The disease is undoubtedly transmissible from one person to another, and indirectly by means of a third person.

Pathology.—The study of recent autopsies and the close investigation of all stages of the experimental disease show the chief feature of the onset to be a very extensive cellular infiltration about the blood-vessels of the cerebrospinal system. This infiltration blocks up the blood-vessels by mechanical obstruction, causing anemia and often necrosis of the parts supplied, in addition to which there is inflammatory edema of the white matter of the cord and ganglion cells. The infiltration subsides to a varying extent after the onset, accounting for the spontaneous improvement so universal in the earlier stages of the disease.

Symptoms.—A much wider range and distribution of symptoms is recognized since the classical investigation of Wickman[1] was published, and cerebral types of the disease are now recognized as well as mixed cerebral and spinal types. It has also been learned that abortive cases occur, that is, cases which resemble infantile paralysis at the outset, but which are not followed by paralysis, or merely by a transitory weakness. One attack confers immunity in children and in animals, which lasts at least for some years.

Prognosis.—It has been learned very recently that something over 15 per cent. of paralyzed cases recover completely within a few months, and that in a longer period of time about 25 per cent. recover with perfect function. Functional recovery may occur without the restoration of the limb to its former size.[2]

Treatment.—With a more definite pathologic knowledge it is evident that the treatment in the acute stage should be the usual measures for any general infection, with local and general rest to promote the absorption of the infiltrated cells in the cord. Hexamethylenamin sets free formalin in the cerebrospinal fluid, and in monkeys has been found to retard or prevent the development of symptoms after inoculation, and is possibly of use early in the acute attack. Isolation of the patient is important. So long as tenderness and pain are present there should be no local treatment in the way of massage, electricity, etc., but the

[1] Die Akute Poliomyelitis, etc., Berlin, 1911.
[2] B. E. Wood, Boston Med. and Surg. Jour., Oct. 5, 1911.

limb should be put at rest, which may be accomplished by the use of plaster-of-Paris bandages if desired. After tenderness has disappeared, massage and electricity, along with muscle-training, that is, the attempt to secure voluntary contraction of muscles or muscle groups which are wholly or partly paralyzed, are of much use, in combination with mechanical and operative treatment.

Operative measures should not be undertaken (except for minor tenotomies) until two or three years after the onset, and not then in very young children.

The operative treatment consists in (1) correction of existing deformities, and (2) the use of measures to improve function. Fixed deformities, where remediable, must, in all cases, be corrected before undertaking mechanical or operative treatment.

SILK LIGAMENTS.

As a substitute for arthrodesis, especially of the ankle, the use of silk ligaments affords distinct advantages. Just as silk extensions in tendon suture become surrounded by tendinous tissue, so do silk stays inserted to serve as ligaments become incorporated and organized. The movements of a flail joint may thus be checked in any desired direction. The most obvious application of the method is found in the ankle, either by itself or in connection with tendon transfer.

If a leg is paralyzed, leaving a flail ankle, a successful arthrodesis leaves a stiff ankle, but if an anterior silk ligament is inserted, dorsal flexion of the foot is preserved, but plantar flexion checked at a right angle. If the foot also drops to the inner or outer side in weight-bearing, a second silk stay at the inner or outer side also checks this tendency.

The operation is performed as follows: An incision 2 inches long is made over the lower third of the crest of the tibia, and the periosteum is split in its length and the edges stripped back a little for about the same distance. Four strands of heavy braided silk, prepared as will be described in speaking of tendon transfer (p. 225), are then quilted into the turned back edges of the periosteum. A second incision is then made over the tarsus in the middle line, and periosteun exposed and divided over one of the tarsal bones. The silk strands are then passed by means of a flat director, with an eye to hold the silk, down from the upper incision subcutaneously, under the annular ligament, to the lower incision, where they are pulled out and then sewed into the periosteum and bones where insertion is desired. The strands are tied with sufficient tension to support the foot at a right angle. The wound is then closed and the joint kept in a slightly overcorrected position for at least two months, while for another month protected use by means of a brace is desirable. Care must be taken to flatten the knots in the silk, as otherwise they tend to chafe through the overlying skin.

The method is by no means limited to the ankle, but will probably prove applicable in other joints, especially the shoulder.[1]

[1] Soutter, Boston Med. and Surg. Jour., June 4, 1908.

TENDON TRANSPLANTATION.

Decided advance has been made of late in the technic of the operation and correspondingly in the improved character of the operative results. The lines of chief advance are as follows: A more rigid selection of cases has been made and the operation restricted to those where it would manifestly be of value. Many unsuitable cases, therefore, are not now operated on which would have been operated on formerly. It has been learned that the substitution of small muscles for large ones is not desirable, either of the peronei muscles, for example, making an inefficient substitute for the gastrocnemius.

To secure the best function, the direction of the transferred tendon must be that of the original tendon, *e. g.*, if one of the peronei is to be substituted for the anterior tibial, the muscle should be dissected from the fibula as far as the upper third of the bone, passed directly across the leg to its inner side, and passed down the leg in the line of the anterior tibial. This means, of course, "silk extension." (See Silk Ligaments, p. 224.) Muscles and tendons should be passed in the subcutaneous fatty tissue, in which they are more likely to preserve good function than in the deeper tissues. Periosteal insertion has almost wholly superseded tendon-to-tendon implantation, and silk extension has been generally adopted, which has naturally extended and rendered more flexible the application of the operation. Simple operations are to be preferred to complicated ones, which were formerly used where a tendon was split and used for different purposes.

The preparation of the silk to be used is of the utmost importance. The silk is boiled for half an hour or more in 1 : 1000 solution of corrosive sublimate. It is then removed with sterile precautions and folded in sterile towels, when it is placed where it will be warm, and dried for two days.[1] Again, with sterile precautions, it is removed from the towels, rolled into balls or on reels, and placed in boiling paraffin, in which it is boiled for an hour. The dish containing the paraffin and silk is then covered with sterile glass and set aside until needed. When the silk is to be used the paraffin is again heated, and the operator takes the silk from the melted paraffin. The use of small silk strands for drainage after operation is not necessary, but allows serum to escape and not to distend the operated area.[2] If used, such drains should be removed in twenty-four hours.

CEREBRAL PARALYSIS.

In the treatment of cerebral paralysis a new operative method has been described which is probably of value in the discovery that the inhibition of sensory impulses has, for a time at least, a restful and beneficial effect upon the spastic and irritated muscles, relaxing the spastic condition and permitting better muscular control. This fact has been made use of by Förster[3] and others, who have divided the posterior (*i. e.*,

[1] F. Lange, Ergebnisse der Chir. and Ortho. Payer and Küttner, Berlin, 1911, ii., p. 1.
[2] R. W. Lovett, Boston Med. and Surg. Jour., April 14, 1910.
[3] Mitteil Grenzgeb. Med. u. Chir., 1909, 20, iii.

sensory) nerve-roots supplying the legs inside of the vertebral canal, with improvement in the motor function.[1] The operation, however, is a serious one, and what its permanent place in surgery will be it is too early to determine. The importance of following the operation by treatment to improve the muscular function is insisted on by the later writers, and so serious an operation is manifestly to be limited to the severer cases.

A less formidable procedure has been proposed[2] in which is obtained temporary inhibition of sensory impulses by the infiltration of the nerve connected with the affected muscles by 70 to 80 per cent. alcohol injected directly into the nerve, which has been exposed by dissection. In the leg the obturator, sciatic, internal popliteal, or anterior tibial nerve is exposed and injected, the particular nerve attacked being determined by the muscles which are overactive. Relaxation of the spasticity and overactivity follows the operation, during which relaxation exercises and drill are possible, having for their aim the cultivation of muscular balance. This relaxation, however, later disappears to a certain extent, and the final place of the procedure has yet to be determined.

CONGENITAL DISLOCATION OF THE HIP.

Treatment.—The improvement in results obtained in the treatment of this affection is shown by the table constructed by Bradford, showing the results obtained at the Children's Hospital, Boston, between 1884 and 1908 inclusive.

Increased experience in the last few years has led to certain changes in the technic which deserve consideration. The method described as that of Lorenz is in general use, but a modification proposed by Schanz[3] is of use in the younger cases. The operator stands on the well side of the patient, who is lying on the back. With the left hand in a left dislocation he seizes the left leg at the knee and flexes and adducts it when flexed. With the pelvis and leg fixed, with a sudden jerk and a continued pull in the direction named, he brings the thigh into strong inward rotation, which is followed by abduction at a right angle to the body. In the easier cases the hip snaps into place almost instantly, but thorough muscular stretching should follow the manipulation.

Although the simple method of Lorenz will suffice for the easier and younger cases, in older children and in certain difficult cases the use of mechanical aids will make possible the reduction of some cases in which the surgeon otherwise would have failed to effect reduction.

The apparatus in present use at the Children's Hospital (Boston) for this purpose is shown in Fig. 98, and represents Bradford's modification of the earlier apparatus.

The base of the apparatus consists of rectangular steel plates which can be fastened at the edge of a wooden table by means of screw clamps. At the edge of the plate are two upright smooth steel rods 1 inch in

[1] Codivilla, Münch. med. Woch., 1910, No. 27.
[2] Allison and Schwab, Amer. Jour. of Orth. Surg., viii., 95.
[3] Zeit. Orth. Chir., xxv., 95.

diameter and 5 inches in height (B^3). These rods are 1 inch apart, and when the patient is in position the rods press upon the ramus of the pubes on both sides. The rods are covered by loose steel cylinders, which are smooth and nickel-plated, and serve to diminish the friction from pressure. In order to secure fixation of the sides of the pelvis, just above the trochanter there are two smooth steel rods at the side, which are held in place by being inserted in holes in the flat steel plate. These rods are adjustable, as there are a number of holes in the plate.

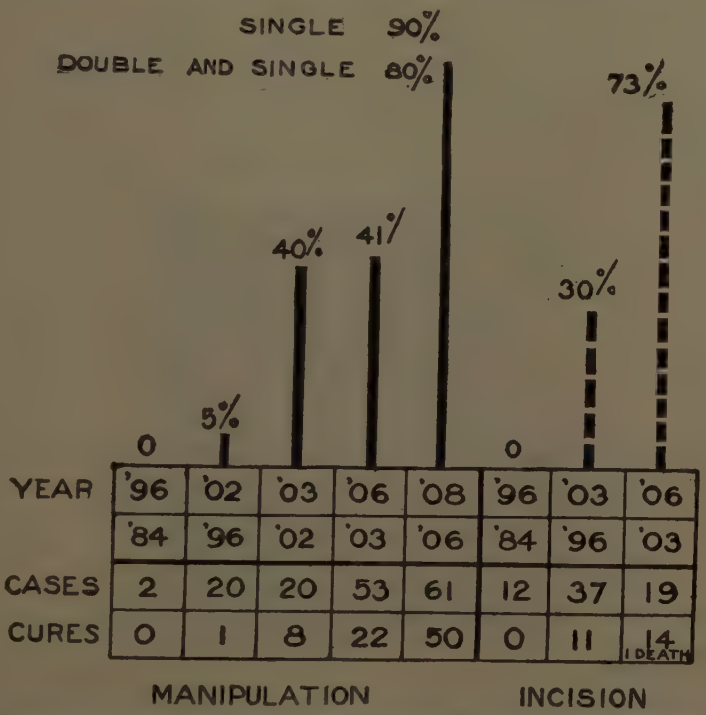

FIG. 97.—DIAGRAM SHOWING PROGRESSIVE IMPROVEMENT IN PERMANENT CURES FOLLOWING OPERATIVE REDUCTION OF CONGENITAL DISLOCATION OF THE HIP IN THE BOSTON CHILDREN'S HOSPITAL BETWEEN THE YEARS 1884–1908 INCLUSIVE. (Bradford, in American Journal of Orthopedic Surgery.)

Rotation of the pelvis is prevented by small metal plates sliding on the side posts (C^1, C^5), which press upon the anterior superior spine and the adjacent portion of the crest of the ilium, and a similar plate may be slipped over the posts which come in the perineum (C^3), which, by means of a catch adjustment, can be pressed down, but will not rise unless released. By this means the pelvis is held firmly, enabling the surgeon to manipulate the femur at will, and to stretch the contracted tissues as he may desire.

Traction is first applied when the patient is placed on this apparatus by securing the ankle by means of a laced leather anklet, to which are fastened side steel rings with a stout cord controlled by a screw, which is

attached to one end of a long rod running down outside of the leg, the end nearest the patient playing upon a socket shown in the illustration at the right of the picture. This enables the surgeon to place the rod in any direction and at the same time employ traction. In the illustration is shown a rod (A) ½ inch in thickness, the distal end of which is inserted into a hole in the steel plate on which the patient lies, the proximal end being manipulated by the surgeon, who uses it to exert pressure and resistance in order to press the head downward in position under the force applied by traction, or uses it to lift the head of the femur into place. The muscles, ligaments, and capsule are thoroughly stretched by this apparatus, after which the patient is removed from the apparatus and an attempt made to reduce the dislocation by the usual technic.

After reduction it is found that the results are better if the limb is placed in an abducted position at an angle of about 90 degrees with the

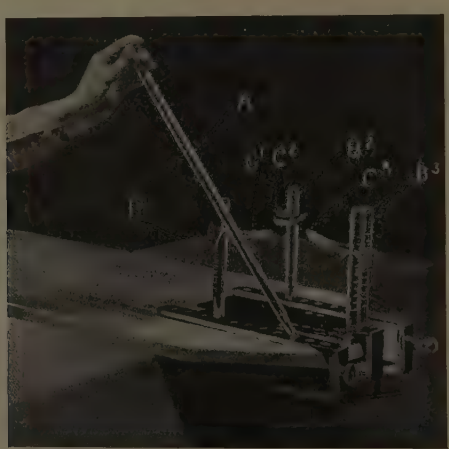

FIG. 98.—APPLIANCE TO AID IN FIXATION OF THE PELVIS AND EXERT PRESSURE UPON THE FEMORAL NECK AND HEAD. (Bradford, in American Journal of Orthopedic Surgery.)
A, Lever rod; B^1, B^2, trochanter rods; B^3, perineal rods; C^1, C^2, plates pressing on anterior superior spines; C^3, plate pressing on symphysis.

long axis of the body, the knee being flexed and the patella pointing forward.

In the application of the spica bandage it is desirable to include the leg and foot of the corrected side and the upper portion of the thigh of the unaffected side, in order to secure accurate fixation at first. At the end of a fortnight the portion of the bandage around the upper part of the unaffected thigh is cut away, and at the end of three or four weeks crutches are given, and the patient, if old enough, is allowed to walk. At the end of two months the plaster is cut off below the knee, and at the end of three months is removed entirely by gradual stages. Massage and manipulation at this stage are desirable, but the activity of the children is generally sufficient to loosen up the stiffness, which will persist for several months.

THE DEFORMITIES OF RICKETS.

Treatment of Bow-legs.—The fracture of the bones of the leg in patients of the proper age for operation with rachitic bow-legs requires considerable force; in the older cases necessitates the use of osteoclasts. It has been stated by Anzoletti[1] that if bone and muscle atrophy be reduced by fixation of the legs in plaster of Paris for from two to four weeks, straightening by manipulation may be accomplished by the hands without a loose fracture and contusion of the soft parts. In practice it will be found that fixation of the legs in plaster of Paris for four weeks in a child of four or five years so softens the bones that they may be broken by the hands with the use of very moderate force. Whether this will offer a better means of treatment than the present one remains to be seen when the after history of such cases is studied as to relapse, but the bearing of the matter is obvious in other directions, since it is evident that prolonged fixation tends to induce fragility. It is, there-

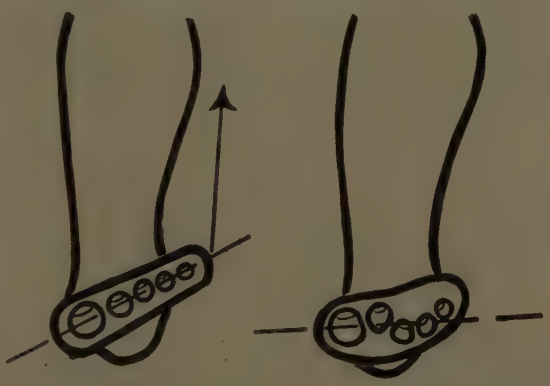

FIG. 99.—DIAGRAM SHOWING ADVANTAGE IN APPLYING A COLLAR AND ALLOWING IT TO SET BEFORE ATTEMPTING TO MAINTAIN POSITION OVER OLD METHOD OF ATTEMPTING TO OVERCORRECT WITH PLASTER STILL WET. (Ehrenfried.)

fore, unwise, for example, to attempt to reduce a congenital dislocation of the hip where the limb has been in plaster for any length of time for fear of fracturing the neck of the femur, and a similar application can be made in other directions.

Club-foot.—A very practical and successful technic in the application of corrective plasters for congenital club-foot has been devised by Ehrenfried,[2] whose conclusion is that practically all cases of congenital club-foot are curable without operation if taken under treatment at the age of six weeks. This conclusion the writer would endorse provided the corrective plaster bandages are properly applied at intervals of two weeks.

Ehrenfried's technic is as follows:

The foot is mobilized by gentle and firm manipulation just before the application of the plaster bandages, which are applied from thigh to

[1] Zentralbl. Orth. Chir., vol. iii., p. 489.
[2] Boston Med. and Surg. Jour., Nov. 18, 1909, p. 741.

tips of toes, with the knee flexed, so as to prevent the cast from twisting on the leg, and allowing a return of the varus deformity. The foot and leg should be evenly and snugly padded with narrow sheet wadding.

If the plaster is applied to the best advantage, three 2-inch rolls are ample in a young infant. Of the first roll, half is used in making a collar about the forefoot. This is applied, the foot hanging relaxed, in such a way, with circulars and reverses, as to lie snugly against the foot. It should extend to the tips of the toes, but should not cramp them nor hide their extremities. It should fit closely against the inner border of the great toe, to its very tip, so as to give efficient leverage in abduction.

FIG. 100.—DIAGRAM SHOWING THE ADVANTAGE OF CIRCULAR TURNS OVER THE THIGH AND UNDER THE FOOT IN GAINING AND MAINTAINING THE GREATEST POSSIBLE AMOUNT OF DORSIFLEXION. (Ehrenfried.)

No plaster is applied until the collar has set. When this has become solid, one can efficiently manipulate the forefoot as a unit and apply a considerable amount of force without cramping or dislocating the toes, causing pressure sloughs; for the pressure is not concentrated, but is distributed evenly through the collar.

The second roll is applied in the form of circular turns over the thigh and under the ball of the foot. These turns are drawn tightly, with the object of flexing the knee and dorsiflexing the foot to an acute angle. If the bandage goes high up on the thigh and far out on the foot there will

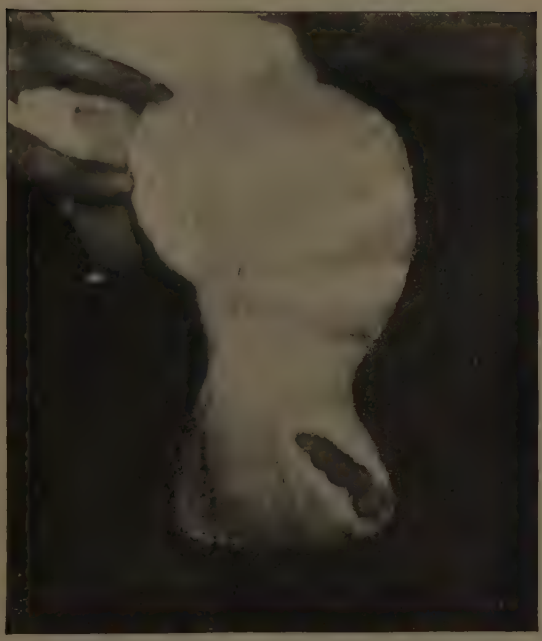

FIG. 101.—PLASTER APPLIED, SIDE VIEW. (Ehrenfried.)

FIG. 102.—PLASTER APPLIED, FRONT VIEW. (Ehrenfried.)
The extreme degree of overcorrection—the foot being directed outward and upward, and the outer border elevated—is apparent.

be a considerable leverage at the command of the operator. The last inches of this roller should be used in making a tight circular or two

about the calf to draw the plaster, which has just been applied, close into the leg.

The third roller is put on immediately and is used to cover in the knee and heel, which have not yet been touched.

A plaster applied in this way will hold all the correction which can be gained by manipulation, with the exception of abduction. To obtain this the foot should be held abducted while the plaster is drying.

The child is not allowed to depart until it is certain from the color of the toes that there is no interference with circulation; and the mother is instructed to bring the baby in immediately or remove the plaster herself if the toes become white or blue. In a resistant foot, where considerable pressure may have to be exerted, there is always some danger, but with this form of plaster it is at a minimum because there is no pressure from plaster in the bend of the ankle. Plasters are re-applied every two weeks, each time after thorough manipulation, until full overcorrection has been obtained.

CHAPTER CV.

SURGERY OF THE LYMPHATIC SYSTEM.[1]

By Frederic Henry Gerrish, M. D.,

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Lymphangioma.—More than a score of *omental cysts* originating in lymph-vessels have been operated upon, but apparently only two have been recognized as such before operation. They develop as do lymphangiomata in other localities, being most common in the young, especially in infants, and may even be congenital. Sometimes they attain enormous size and may be attached to any abdominal organ. Their contents are a clear fluid, amber or rosy in color, are neutral in reaction, and coagulate on boiling. Any part of the omentum may be involved. The blood-vessels of the parts concerned are much dilated, and from distention may rupture into the cysts. These lymphangiomata should be distinguished from primary hydatids or hepatic cysts, dermoids, and ovarian cysts. The so-called chylous omental cysts occur in the mesentery and not in the omentum. Practically, there is no method of making a positive diagnosis before operation. Most of the reported cases have been mistaken for tuberculous peritonitis with ascites or ovarian cyst with a long pedicle. In operating it may be necessary to remove nearly the whole omentum. There should be practically no mortality if the patient is in a suitable condition for operation.

Lymphedema.—*Cancer of the breast* in about one-sixth of the cases produces lymphedema of the corresponding arm from obstruction of the lymph-vessels, and the same condition commonly ensues upon the thorough removal of the axillary nodes. On an average, these patients survive less than a year, and generally suffer great pain, as well as almost total incapacity of the limb, from interference with joint movement and the heavy burden of the water-logged member. In most cases pleuritic effusion follows the arm-dropsy. These cases have been the despair of surgery, amputation having as its only alternative the administration of morphin, with the certainty of the imposition of the drug addiction beyond control. Handley, recalling an observation of a case in which a silk ligature remained embedded in the tissues ten years without harm, conceived the idea that such a thread might serve as a channel for fluids, and, acting accordingly, buried a number of them in the subcutaneous areolar tissue of a dropsical arm and saw great relief from the edema and pain. He has operated upon 15 cases, with only 1 death, and that occurred in a case which was unsuitable for the operation. In the

[1] Supplementary to Chapter XXIX., Vol. II., p. 584.

favorable cases there was complete relief of the pain in twenty-four hours unless it was due to some cause other than the edema; rapid diminution of tension and swelling in the whole area drained, and permanence of this subsidence unless pleural effusion occurred to interfere with the drainage; the disappearance of the paralysis if it was not of long standing; and improvement of the general condition of the patients, partly from relief of the suffering and removal of the incapacity and partly from the abandonment of opiates, which ceased to be needed.

The operation by which these results are obtained is called *lymph-angioplasty*, and consists in establishing in the edematous parts artificial channels as substitutes for the natural vessels which have become obstructed. The tissues of the arm are drained by two U-shaped lines of No. 12 silk, one on the front and one on the back. These are made to converge toward the posterior border of the deltoid; then they are made to radiate, and end in the scapular region. If there is edema of the trunk, some of the threads are run across to the opposite side and to the loin of the same side.

The operation is performed as follows: Two lines of silk, more than twice the length of the limb, are threaded into a long-eyed probe, which is thrust deeply into the areolar tissue through a $\frac{1}{2}$-inch incision in the skin at the wrist on the flexor aspect. The threaded probe is passed upward as far as practicable, and is then withdrawn with the silk through a small incision made at the highest point of its passage. It is then inserted at the point of its emergence and carried upward again; and the process is repeated until the point chosen for the convergence of all the lines is reached, where a 1-inch incision is made, and the silk-laden probe drawn out. The other half of the thread is now treated in the same way, beginning at the wrist incision, and directing the course of the probe parallel to and at a distance from the first track. Then the extensor surface of the limb is similarly furnished with artificial channels, and the eight threads are brought out at the posterior border of the deltoid. These are then embedded in the areolar tissue of the back in pairs by using a probe, which is some inches longer than the threads which it is to carry. When the probe has been inserted its length the silk has become detached from it, and the probe can be pulled back without removing the threads. The incisions are then closed with sutures. The only thing to be feared in the operation is the contamination of the silk. The second half of each set of threads must be wrapped in sterile gauze while the first half is being inserted. General anesthesia is needed. The operation is only advisable in severe cases of obstruction. In the milder cases, massage, bandaging, and elevation of the limb should be employed.

Ascites.—This plan of draining an accumulation of fluid into the subcutaneous areolar tissue has been employed also in treating ascites. Paracentesis, while commonly affording immediate relief to the pressure-symptoms, is of only temporary advantage, for the peritoneal cavity is soon refilled, and various disadvantages and even dangers attend this procedure. The sudden withdrawal of the fluid, with the consequent

drop in the intra-abdominal pressure, is likely to result in augmentation of the transudation from the peritoneum, and possibly in hemorrhage, and a vast amount of fluid which is rich in nutritious material is wholly wasted. These objections can be avoided if the ascitic accumulation is gradually distributed into the areolar tissue of other parts of the body; the relief of tension permits a more normal flow in the lymph-vessels and the portal system, and the kidneys and abdominal organs generally are more free to do their work competently.

In a case of atrophic cirrhosis Handley passed a stout needle threaded with silk, such as he uses in lymphangioplasty, in and out at a number of points through the peritoneum and subjacent tissues of the right iliac region external to the mesocolon, leaving several series of short loops projecting into the cavity. The ends of these threads are pushed into the areolar tissue of the front of the thigh, passing near the anterior superior spine of the ilium and behind the inguinal ligament. The immediate result was not satisfactory and another paracentesis was needed, but ultimately great benefit ensued, seeming to justify extensive trial of the method.

Wynter considers the femoral canal the best place through which to drain an ascitic pool into the areolar tissue, but the operation is confessedly difficult and the method presents marked defects, as the opening is liable to be blocked by omentum or by adhesion of a portion of intestine to its margins. However, nearly half of the cases thus treated were cured.

Probably the easiest method of operating is Handley's. He thrusts a curved trocar through the abdominal wall in the middle line 2 inches above the pubic crest. The stilet is withdrawn and a large blunt seeker is put into its place. The femoral ring is exposed by a curved incision whose convexity is outward, the flap thus made preventing the coincidence of the peritoneal opening and the cut of the skin. The point of the seeker is made to enter the femoral canal, where it can be felt by the finger, and presses the peritoneum forward, so that the membrane can be seized by a forceps on each side and safely slit between them. Each of these lateral flaps is sutured to the inguinal ligament in order to keep the opening from closing. The skin is then sewed up and the peritoneal cavity drains into the areolar tissue of the thigh.

In this connection it is pertinent to mention a treatment by which the ascitic fluid is drained into the venous current. The upper part of the internal saphenous vein is exposed, divided about $3\frac{1}{2}$ inches from its termination, and the distal end ligated. The proximal portion is dissected up and its tributaries tied. The incision is then carried upward over the crural arch, the abdominal wall opened for $\frac{1}{2}$ inch or perhaps a little more, and the vein sutured into the opening. The incision is then closed. Larger experience than has yet been reported is needed to determine the value of this operation.

Finally, under this head should be mentioned a plan of draining an ascites into the subcutaneous tissue of the abdominal wall by means of a glass tube with a flange at each end, one of these resting against the

peritoneum, the other on the linea semilunaris. The incision through the skin is made in the middle line in order to avoid collocation of the openings. The omentum needs to be ablated sufficiently to prevent its occluding the tube.

Hodgkin's Disease.—No new light has been thrown on the pathology of this malady in the past few years, but advance has possibly begun in its therapy. The treatment by the *x*-rays has been followed by diminution of the characteristic enlargements, but it is too early to make a claim of permanent results. Those who are best acquainted with the effects of the rays will be most cautious in their attitude and most conservative in their promises of improvement and of the innocuousness of the treatment. No one will expect a few applications to secure success, and the well informed will protect themselves by a frank declaration to the patient that immunity from worse than annoying effects does not always attend the sagacious employment of this mysterious agency by the most experienced operator.

Wounds of the Thoracic Duct.—Cases of accidental injuries of this duct during operations for the removal of tumors from the neck are frequently reported, and practically always with a statement of favorable result of treatment. The management of the cases is as various as ever, advocates of suture, ligature, implantation in the jugular, clamping, and packing respectively sustaining their contention with reports of a happy termination. One is almost tempted to think that it makes little or no difference which method is adopted; and yet it must be obvious that a restoration of the tube by suture is the ideal plan if the duct has not been completely severed, and either this procedure or implantation when the cut extends all the way across. Whoever has the misfortune to need to select any plan is entitled to derive such comfort as he can from Wendel's belief that, as a rule, the thoracic duct anastomoses with the right lymphatic or with the azygos or renal veins; and (if he cannot stop the leakage) from Fredet's statement that the loss of lymph from a wounded thoracic duct is unimportant if the amount is moderate, and that the prognosis is generally favorable.

CHAPTER CVI.

SURGERY OF THE SKIN AND ITS APPENDAGES.*

By John A. Fordyce, M.D.,

New York.

Furunculosis.—In the treatment of recurring furuncles an endeavor should be made to ascertain the local focus of infection. In patients with recurrences about the neck reinfection frequently takes place from the scalp. Disinfection of the latter and use of ointments containing sulphur and salicylic acid will usually bring the affection to a termination. The axillary and other folds, which may be the site of intertriginous inflammation of various kinds, are also to be thought of as possible sources of infection.

Vaccine therapy has proved a valuable adjunct to the treatment of boils and carbuncles. Many clinicians prefer the autogenous vaccine, but, in my experience, equally good results are obtained from the use of stock polyvalent staphylococcus vaccines. Beginning with a dose of 200,000,000 organisms, the injection is repeated every week or ten days, or it may be increased until 400,000,000 are given. The dosage and the interval between administrations are best determined by the clinical effect produced. Care should be taken that the negative phase has subsided before the injection is repeated.

Treatment of Nevi.—Refrigeration by solid carbon dioxid has practically superseded other forms of treatment in the removal of nevi. It is attended by very little pain and usually results in a good scar. The liquid gas is procurable commercially in large iron drums, from soda-water manufacturers, or in small cylinders, from automobile supply houses. To collect the snow the drum is inclined so that the outlet is at the lower end. A piece of chamois skin is then tied to the nozzle, forming a little pouch, or a special attachment may be screwed on. In the latter instance the snow is molded in the device by packing solid with a rod or hammer. If the loose snow is collected in the chamois, it may be rolled in this, or it can be packed in cylindric or conic square metal or hard-rubber molds to form a solid stick or pencil, the ends of which can be further sharpened with a knife, according to the needs of the case. The reaction depends on the duration of the application, the amount of pressure, and the extent of surface treated. All grades may be produced, from a mild stimulating inflammation to one of deep degree, in which the tissues are completely destroyed.

*Supplementary to Chapter XXX., Vol. II., p. 616.

This treatment is followed by a burning sensation and blistering. Generally speaking, for lesions less than ½ inch in diameter one application is usually sufficient; for large or irregular ones, several are required. For the treatment of flat, hairy, and pigmented nevi applications of ten to thirty seconds, in children or women with delicate skins, usually suffice, while in individuals with a coarse skin an application of one minute or longer may be necessary. The vascular, especially the hypertrophic variety, and papillomatous nevi generally need a number of applications, lasting twenty to forty-five seconds each. Pusey[6] advises, as preliminary to refrigeration, *x*-ray exposures which render the tissue more susceptible to the effects of freezing. As a rule, no after-treatment is necessary or only a simple protective dressing.

Dermatitis Venenata.—The irritant in ivy- and sumac-poisoning, according to Pfaff,[5] is a fixed oil, toxicodendrol. It is very tenacious, adheres persistently to the parts with which it comes in contact, and may retain its activity on contaminated clothing or other objects for an indefinite period. Vigorous measures are, therefore, required for its removal. This is best accomplished by thorough scrubbing of the affected surfaces with soap and water and a hand brush, or by washing with alcohol, which is a solvent of the oil. It should be used in the strength of 95 per cent. and freely. As lead acetate precipitates the oil, Pfaff recommends this agent in an alcoholic solution, the alcohol serving to remove the insoluble compound which is formed. For the dermatitis, calamine and zinc lotion with phenol (phenol, ½ to 1 dram; calamine, 1 dram; zinci oxid, 3 drams; glycerin, ½ ounce; liq. plumbi subacetat. dil., aqua calcis, each 4 ounces) affords most relief.

Primrose dermatitis deserves special mention, owing to the frequency of its occurrence and the failure to recognize its nature. Several species of the primrose plant are capable of provoking in susceptible individuals an eruption, which may develop within a few hours to two to three days after contact with the plant, with exceptionally a latent period of two weeks (Nestler[4]). Preceded by burning and itching, the reaction varies in intensity from an acute erythematovesicular or bullous dermatitis to a subacute scaling inflammation, or, after repeated attacks, a chronic infiltration (Foerster[3]). The eruption is usually limited to the exposed parts or areas which have become contaminated with the irritant. The toxic principle resides in the secretion exuding from the glandular hairs of the leaves; its chemical composition is not known (Nestler). The secretion is soluble in alcohol, ether, and chloroform. Thorough cleansing of the parts with alcohol at the beginning of the attack is said to modify it. When the dermatitis is established, soothing lotions like calamine and zinc are indicated.

Epithelioma.—In the treatment of superficial rodent ulcer, especially that form which is met with on the side of the nose and about the inner canthus, where surgical procedures are apt to be followed by marked deformity, curetage followed by the acid nitrate of mercury, as recommended by Sherwell, gives excellent results. This caustic is not as destructive as arsenic or chlorid of zinc, and can be

employed where the more powerful agents are contraindicated. In the small epitheliomas of the eyelids, where it is important to avoid cicatricial tissue with resulting deformity, Abbe and others have obtained excellent results with radium. The superficial epitheliomas occurring about the nose and canthi are exceedingly rebellious to any method of treatment, and necessitate continuous observation over a long period of time. Not infrequently the growth recurs in the scar-tissue and at the periphery, but if these recurring nodules are recognized and immediately destroyed the eventual cure of the disease may be brought about. My procedure is usually the following: Thorough curetage with a small ring dermal curet, followed by the application of the acid nitrate of mercury, unless a more active caustic is indicated. The slough produced by the acid nitrate of mercury usually separates in a week or ten days, leaving a healthy granulating surface, which readily heals with a thin pliable cicatrix. Brilliant results are sometimes obtained by the use of the *x*-rays in the more superficial cutaneous epitheliomata. I have a number of cases where no recurrence has been noted after three or four years. In other cases relapses following the apparent cures from the *x*-ray have been more serious than the original affection. Carbon-dioxid snow is favorably reported upon by many dermatologists, both as to cure and cosmetic results. Its use should, however, be confined only to the small superficial tumors of the basocellular type.

It may be stated briefly that the surgeon should not confine himself to one method of treatment of epithelioma of the skin. In regions where the lesion can be freely excised this is the method of choice. In other places, curetage and cauterization give equally good results, but in the small pearly epithelioma of the lower eyelid, where it is important to avoid scarring, radium should be given a trial. In the more extensive and infiltrating growths seen about the face, where surgical procedures would be attended by great disfigurement, thorough curetage and the application of a more powerful caustic, as chlorid of zinc or arsenic, should be considered. The former is most commonly employed as Bougard's paste.*

A thick layer is spread on gauze and allowed to remain in contact with the lesion for twenty-four to forty-eight hours, depending on the depth of destruction desired. The slough usually separates in one to three weeks. Arsenic is likewise applied as a paste, either after the formula of Marsden (arsenious acid, 2 parts; mucilage of acacia, 1 part) or stronger. It usually requires twelve to thirty-six hours for this

* The formula for Bougard's paste is:

R. Farinæ tritici (wheat flour) } āā ℥j
Amyli }
Acid. arsenos. pulv. gr. viij
Hydrarg. sulph. rub. ℈ij
Ammon. chloridi. ℈ij
Hydrarg. chlor. corros. gr. iv
Zinci chlorid. cryst. ℥j
Aquæ fervid. ℥iss.

The first six ingredients are mixed together. The zinc chlorid is dissolved in the boiling water and added to the other mixture under thorough rubbing.

preparation to exert its action. The pain may be mitigated by eucain or cocain mixed with the paste.

Treatment of Lupus Vulgaris.—Further experience with the use of the Finsen light has confirmed the original claims regarding it. In cases where the process is superficial the light is employed alone; where it is situated more deeply and is ulcerative, a course of *x*-ray exposures is beneficial after the light has brought about the destruction of the lupus nodules; and, where ulceration is extensive, a preliminary treatment with the *x*-ray will often hasten the cure. Although the Finsen light gives the best cosmetic results, it is not generally available and other methods must be considered. Röntgentherapy will in some instances bring about a cure, but it not infrequently fails. In those cases seen early, and where the disease is circumscribed, the tissue may be excised, or destruction of the lesion may be undertaken by curetage, supplemented by cauterization with zinc chlorid, pyrogallic acid, or pure carbolic; by the dental burr; scarification or the Paquelin or galvanocautery. Success in the use of these destructive agents depends upon the thoroughness with which they are employed and careful supervision of the case, so that they may be effectively applied as soon as relapses occur.

Tuberculin is a valuable adjuvant in the treatment of some forms of cutaneous tuberculosis. In my clinic very good results have been obtained with the tubercle bacillus emulsion (B. E.), of which an initial dose of $\frac{1}{50,000}$ mg. is given with a geometric increase of 25 per cent. weekly. In cases with ulceration, and in scrofuloderma where not infrequently we are dealing with a mixed infection, the cure has been hastened by the combined use of tuberculin and staphylococcus vaccine.

Treatment of Lupus Erythematosus.—The results obtained in this disease are more unsatisfactory than in any other dermatosis. Regardless of the method employed the result is always a scar, as this is the natural termination of the affection. The application of various local remedies not infrequently affords a temporary cure, but relapses are numerous.

In the early hyperemic stage soothing applications, like calamine lotion, are indicated. Lotio alba with resorcin is also useful (zinci sulphat, potass. sulphuret, each 1 dram; resorcin, 1 to 2 drams; aq. rosæ, 4 ounces). Repeated exfoliation of the epidermis by a 25 per cent. aqueous solution of resorcin is sometimes followed by improvement or lessening of the hyperemia.

In the less acute stage curetage of the edge of the patch, followed by pyrogallic acid in 10 or 20 per cent. ointment, sometimes benefits. The treatment recommended by Holländer, viz., painting the lesions with tincture of iodin and the administration of quinin in doses of from 10 to 30 grains daily, has been successful in some cases. The use of liquid air or carbon-dioxid snow is also credited with having brought about many cures. It is employed in the same manner as for nevi, applications lasting from ten to sixty seconds, according to the amount

of infiltration. Ionic medication is highly recommended, especially in Great Britain, where the best success appears to have been obtained. Using 20 per cent. zinc sulphate, or copper sulphate solution, each patch is subjected to about 5 to 7 milliampères of current for ten to twenty minutes, which procedure is repeated every week or ten days.

Röntgentherapy also has its adherents, Sabouraud believing that this method gives better results than others. His practice is to administer the rays in a dosage sufficient to cause a violent reaction, healing taking place after several months, with a cicatrix. Finsen light, ultra-violet light, and the high-frequency current have also been employed.

Tuberculin is often given in conjunction with the local treatment, but, excepting in isolated cases, little is accomplished. On theoretic grounds much could not be hoped for from its use, as the majority of these cases are negative to the von Pirquet and Moro tests.

Sporotrichosis is a mycotic infection due to the Sporothrix Schenkii. Histologically and clinically it has so many features in common with syphilis and tuberculosis that it is frequently confused with one or other of these diseases. It has a wide geographic distribution, occurring in North and South America, in Europe, Africa, and Ceylon. One form of the disease was first described by Schenck[7] in this country in 1898, but it is only since 1906, when De Beurmann and Gougerot[2] published the results of their experimental work, that the affection has attracted widespread attention. Since then the number of cases observed in Europe and this country has grown.

In the majority of American cases there has been a history of trauma, followed by a low-grade inflammation along the lymphatics, usually of the arm, with the development of subcutaneous nodules. The latter contain a gelatinous pus, from which the sporothrix is obtainable in pure culture. These abscesses may or may not break down, in the latter event leaving indolent sinuses or ulcers. The affection also occurs as subdermic, dermic, and epidermic lesions disseminated over the body. This appears to have been the form most frequently encountered in Europe. The nodules developing in the subcutaneous tissue De Beurmann has designated the syphiloid type, and the broken-down lesions, showing a papillomatous or fungating condition, as the tuberculoid type. More rarely the lesions develop primarily in the cutis, as reported by Monier-Vinard, or in the epidermis.

The oral and conjunctival mucosæ have shown lesions in association with those of the skin. The disease may also involve the muscles, bones, and lymphatic glands. Lesions of the joints and testicle have also been reported.

Histologically, three types of reaction are described by De Beurmann and Gougerot: (1) a lymphoconnective tissue or syphiloid; (2) an epithelioid, with giant cells, or tuberculoid; (3) a polynuclear or suppurative. The organism is only rarely demonstrable in the tissue or pus. Recently McDonagh has succeeded in staining the fungus in sections with pyronin and methyl green. It is readily cultivated on solid media, preferably

the peptone-glucose-agar of Sabouraud's formula for ringworm fungus (peptone, Chassaing, 1; glucose, 3.7; agar, 1.5; water, 100). On this medium colonies appear in four to ten days as small white acuminate points, surrounded by a finely rayed areola. As they increase in size they become brown and convoluted. The fungus consists of branching slender mycelia and ovoid spores. It also grows upon caterpillars, flies, larvæ, etc., and upon vegetable substances. The source of infection is not definitely known. As the fungus has been found on decaying vegetable matter it has been suggested that unclean vegetables may be responsible.

In making a diagnosis, tuberculosis, syphilis, glanders, simple pyogenic abscesses, and possibly blastomycosis are to be considered. Differentiation can readily be made by cultural methods, the complement fixation test, the agglutination test, or the intradermal reaction. According to Widal and Weil, the spores agglutinate when mixed with the patient's serum in dilutions of 1: 200 to 1500.

Sporotrichosis occurs spontaneously in rats, dogs, and horses, in the latter producing epizoötic lymphangitis. It has been successfully inoculated in laboratory animals, the rat being especially susceptible. In this animal an orchitis, fifteen to twenty days after intraperitoneal inoculation with material from a suspected case, is considered by De Beurmann and Gougerot as diagnostic.

Treatment.—The disease yields in a few weeks to potassium iodid in doses of 10 to 30 grains three times a day. Locally, applications of weak iodin lotions are useful.

Infectious eczematoid dermatitis possesses surgical interest on account of its etiologic relationship with pus-infected foci. Irritation of the skin by discharges from infected traumatisms, abscesses, furuncles, sinuses left after operation on bones, etc., not infrequently gives rise to a cutaneous reaction indistinguishable from true eczema. The eruption may assume diverse forms, such as a dry scaling dermatitis, or large moist areas with the occasional occurrence of papillomatous overgrowth of the epidermis. Again, it may simulate an acute vesicular eczema, or there may be a more intense reaction with a raw exuding surface, the epidermis exfoliating in sheets. The infection is distinctly auto-inoculable, and may be carried to contiguous or distant parts. It is often very rebellious to treatment, and a chronic dermatitis may persist for months or years. While in many recovery is permanent, in others, with a lowered resistance to pus infection, recurrences take place, such as furuncles and abscesses, with a subsequent eczema. It is possible to attribute this increasing susceptibility to the irritant and the recurrences to a state of anaphylaxis.

In the class of patients in whom this affection is frequently met with —namely, lodging-house inmates, whose resisting power is lowered by alcohol, lack of proper food, and hygiene—it sometimes leads to very extensive forms of dermatitis and even to death. In a fatal case, seen by me at the City Hospital during 1911, the disease began as an infectious eczematoid dermatitis about the genitals, neck, and face, and

developed rapidly into a moist dermatitis, involving practically the entire body. It was attended by high temperature and great prostration. The autopsy revealed no characteristic lesions. In this case vaccine treatment failed to produce any benefit.

Treatment.—If a large surface is involved, rapid results are sometimes obtained by the use of Lassar's paste (acid. salicyl., 10 grains; zinci oxid., amyli, 2 drams, equal parts; petrolat., q.s. ad 1 ounce). A solution of zinc and copper (zinci sulphat., 7; cupri sulphat., 2; aqua, 200), either in full strength or diluted with 2 or 3 parts of water, according to the extent of the surface, applied on compresses or tampons every hour or two, will often control a dermatitis of this character, as well as discharging areas which originate from impetiginous lesions about the face. In the localized forms that originate from discharging sinuses or

FIG. 103.—INFECTIOUS ECZEMATOID DERMATITIS FOLLOWING AN ABSCESS OF THE BREAST.

abscesses, protective ointments, containing a small percentage of sulphur or ammoniated mercury, are the best applications. For the obstinate intertriginous inflammations of streptogenic origin, described by Sabouraud, a 10 per cent. silver nitrate solution will usually start the healing process in the fissures which follow these forms of dermatitis, especially back of the ears in young children. In addition to the local treatment, general hygienic measures are indicated. Vaccines, although not uniformly successful, are worth a trial.

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CHAPTER CVII.

THE SURGERY OF THE NERVES.*

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NEURALGIA.

Tic Douloureux.—Operative Treatment.—Complete removal of the Gasserian ganglion or division of its sensory root is the only sure cure for tic douloureux. So-called recurrence after such operations is a sure indication that it was incomplete. The sensory root never regenerates, nor do the peripheral neurons of the nerve after the removal or destruction of all the nerve-cells of the ganglion. Sicard[13] recommends alcoholization of the ganglion through the foramen ovale, which he has carried out on the dog and the human cadaver. It only involves division of the superficial muscles.

However, on account of the difficulty and danger of operations on the ganglion or its sensory root, peripheral operations on the nerve or nerves involved have grown in favor, as they are without danger, readily performed, and offer a lengthy if not permanent cure. The best methods are:

(A) The slow avulsion of the nerve, both centrally and peripherally, after its exposure (Thiersch's method, Vol. II., p. 756). For this purpose it is better not to divide it, but to seize it obliquely with a special curved hemostatic forceps and twist it. Laplace[7] has called special attention to the importance of twisting the nerve very slowly, taking twelve to twenty minutes before the nerve breaks. One can thus pull out or avulse 1½ or 2 inches in the central, and 1 to 4 inches in the peripheral end.

As no nerve in the body regenerates so completely and against such obstacles as the trifacial, apparently on account of the large number of ganglion cells in proportion to the size of its trunk, it is best to interpose some impenetrable substance, such as metallic foil, gutta-percha or silver screws, between the divided ends wherever the nerve passes through a bony canal. "Cures" by this method may last two or more years and, occasionally, may be permanent. Jaboulay and Cavaillon[6] recommend the combination of sympathectomy with avulsion in trifacial neuralgia resisting medical treatment. The former method, which alone, they claim, gives a long period of relief, has not been used much by American surgeons.

* Supplementary to Chapter XXXII., Vol. II., p. 686.

(B) *Injections.*—1. *Osmic Acid.*—This requires the exposure of the nerve, which may be easily and quickly done in the case of the infra-orbital, mental, superior and inferior palatine, and supra-orbital nerves, and in all but the latter through small incisions in the buccal mucosa. It can be done under local analgesia or nitrous oxid or ether anesthesia. No incision is necessary for the posterior palatine nerve. The nerves and their canal should be injected to the extent of ½ inch. There are no inconveniences, complications or failures, such as sometimes occur from alcoholic injections. J. B. Murphy reports some patients "cured" for four and a half years, and many two and even three years, but the usual time of relief is between fourteen and eighteen months. Second injections give a greater average period of relief than primary ones,

FIG. 104.—NEEDLE PLACED FOR INJECTION OF MIDDLE BRANCH. (Patrick.)
Ink-mark above indicates orbital process of malar bone. Small dot a short distance posterior to needle and at slightly higher level indicates where needle was inserted for injection of inferior branch.

though they are a little more difficult, owing to the cicatricial tissue around the foramina. The latter should be reached subperiosteally. It should be remembered that the canal from the mental foramen passes downward, inward, and *forward.*

(2) *Alcohol.*—In the last five years this has been used, in injections for neuralgia, more than any other substance. The chief reasons are that the injection may be made at the emergence of the nerve at the base of the skull, and the simplicity of the method of employment without incision and, hence, without a scar, and usually with only local analgesia in the skin and deeper tissues. The average period of relief of pain is less than after avulsion or osmic acid injections and varies very much. This is because, being done in a blind way, the injection

is not always made into, but often only close to, the nerve. According to Patrick,[9] the majority of injections are not made within the nerve-sheath, and this is not necessary to relieve the pain. But, unless the injection is within the sheath, the relief may not be immediate and it does not last long—only a few weeks or months. It is, therefore, wise to continue the injections until one penetrates the nerve. This is indicated by the analgesia which follows in the distribution of the nerve. The injection may be repeated in twenty-four or forty-eight hours if there is little or no edema or reaction, or we may wait five to seven days. The patient may refuse repeated injections if the pain is temporarily relieved. Relief of pain may last over two years, while other cases relapse in a few months or even weeks, the latter being instances of incomplete injection. In 123 cases of trigeminal neuralgia, treated by Schlösser, relapse did not occur, on the average, until after ten months. In 1909 Kiliani reported 190 cases, with 5 failures, and 21 per cent. free from pain eighteen months or more. The average number of injections required was three.

FIG. 105.—SAME AS FIG. 104; FRONT VIEW. (Patrick.)

FIG. 106.—NEEDLE PLACED FOR INJECTION OF INFERIOR BRANCH. (Patrick.)

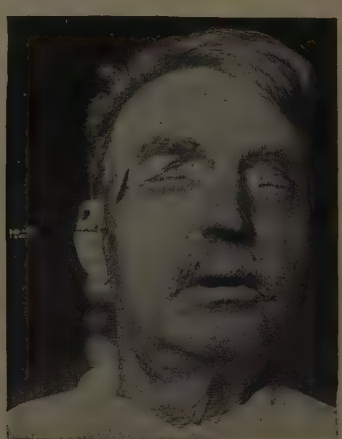

FIG. 107.—SAME AS FIG. 106; FRONT VIEW. (Patrick.)

After relapse, reinjection gives another period of relief. The local formation of sclerosed tissue about the site of the injection, which may interfere somewhat with the movements of the jaw and with a reinjection, is largely obviated by adding no chloroform to the solution. Some add cocain, novocain, or stovain (1:200 or 1:300) to the solution to diminish the immediate and temporary painful effects of the injection. Schlösser says that general anesthesia should be avoided, as the pain on entering the nerve indicates the proper point for the injection. Local analgesia may be employed, but only at the site of the puncture of the skin or mucosa.

The injection of 70 or 80 per cent. alcohol in a nerve causes a degeneration of its fibers, as a result of which they are absorbed until only the neurilemma remains. Hence, such injections should not be employed in motor or mixed nerves, except in neuralgia in a stump. The only exception to this rule is the inferior maxillary division of the trifacial. The successful injection of this nerve is followed by some unilateral paresis of the muscles of mastication (due to degeneration of the masticator nerve). This produces some difficulty of mastication, with a tendency to progressive amelioration, or, at least, tolerance.

According to Schlösser, the injection must be made near the point of origin, so that as many of the fibers as possible may be reached. But Sicard[13] has shown that in many cases the injection of the peripheral branches, in their foramina or canals, may be very useful. These are fairly easily reached. Of course they may be injected after exposure, as in osmic acid injections, but this is unnecessary and is rarely done. Alcohol injections are usually given in the inferior maxillary at its emergence from the foramen ovale, less often into the superior maxillary at the foramen rotundum, or the supra-orbital at its notch or foramen.

Technic.—There are two principal methods, the buccal and the cutaneous.

The injection of the first division at the back of the orbit is dangerous and should not be attempted. It should be made at the supra-orbital notch or foramen. The second division may be reached by inserting the needle below the zygoma, 0.5 cm. behind a vertical line drawn from the posterior edge of the orbital plate of the malar bone, in a direction inward and slightly upward, through the pterygomaxillary fissure into the sphenomaxillary fossa, in the posterior wall of which lies the foramen, in front of the pterygoid plates, near their base. As the sixth nerve lies at the apex of this fossa, it must be guarded against the action of the alcohol by not inserting the needle over 2 inches except in broad skulls. The upward inclination is such that the tip of the needle at the depth of 2 inches should be on a level with the lower end of the nasal bones. The injection at the foramen rotundum is usually quite painful, that of the other branches very little so.

To reach the inferior maxillary nerve at the foramen ovale by the buccal method, the original method of Schlösser; the needle is introduced at the outer side of the last upper molar and pushed upward and backward along the external pterygoid plate until it is arrested. Then the

base of the needle being lowered, the tip is advanced a fraction of an inch until arrested by the base of the skull, along which it is worked back for nearly ½ inch, when it is felt to enter the foramen. This requires practice, which is best obtained on the cadaver.

The cutaneous route is now more commonly used. The needle is inserted just above or below the zygoma. If below the zygoma, it should pass through the triangle bounded by the latter and the coronoid and condyloid processes of the mandible. The point of entrance is 1.5 to 2.5 cm. in front of the anterior root of the zygoma, or just 1 cm. in front of the preglenoid tubercle. If above the zygoma, it may have to be inclined a very little downward; if below, a little upward and backward. It is shoved inward until it strikes the external pterygoid plate at its upper end. Then it is edged backward until it passes behind the plate, where it meets the nerve at its exit from the foramen. If the tip of the needle is pressed slightly backward so as to touch the nerve, pain is usually felt in its distribution. If the needle is then withdrawn a trifle and pushed inward a very short distance it should puncture the nerve about 1⅗ to 2 inches from the surface of the skin.[10] Murphy strongly favors the route above the zygoma as being safer and surer. In 2 cases Sicard was unable to reach the foramen ovale from below the zygoma. The needles should be 2½ to 4 inches long. It is convenient to have the first 2 inches marked in centimeters. Schlösser uses needles of such thick tubing that the edge does not cut at the point of the needle, so that no arteries or even veins are injured. Sicard, on the other hand, uses needles of fine caliber, as they cause less pain and are less apt to wound important vessels. If a needle with a blunt stylet is used it is less apt to injure the vessels. On reaching the nerve the stylet is withdrawn. The strength of the alcohol should be 70 or 80 per cent., or even up to 90 per cent., for second injections, and the amount 1½ to 2 c.c.

Postoperative Sequelæ.—The patient should be warned of the temporary board-like swelling which follows a successful injection. Usually there is only a somewhat uncomfortable sense of tension or of contusion, sometimes a diffuse headache, lasting one to three days. After the edema disappears the area is as supple as before, and does not present trophic disturbances. Some muscular sclerosis of the pterygoids may follow repeated injections about the foramen ovale. It may limit the movements of the jaw, and occurs less commonly if no chloroform is added to the injection. After injection at the foramen rotundum transient paralysis of the abducens has been noted in a few cases, also myosis of the corresponding eye, but the latter may be present in facial neuralgia before injections. It disappears in three to five weeks after the injection.

Paresis of the lower part of the face (ala nasi, nasolabial fold, upper lip) may follow attempted injection of the infra-orbital foramen, in which the needle has not penetrated the canal and the alcohol comes in contact with terminal twigs of the facial nerve. It disappears, as a rule, in twelve months or so. Unilateral paresis of the muscles of masti-

cation indicates a successful injection of the inferior maxillary nerve. A hematoma may follow an injection, especially of the supra-orbital or infra-orbital branches, from puncture of the vessels. Edema of the eyelids may occur, but it disappears rapidly, inside of forty-eight hours. Slight ptosis, lasting a week or so, may follow the edema of the upper lid. Patrick leaves the needle *in situ* two minutes to avoid oozing. The puncture-opening is touched with collodion to seal it.

(3) *Air.*—The injection of filtered air (Cordier's method), a simple and safe method in the treatment of many forms of neuralgia, is not well suited for the treatment of facial neuralgia, unless of some of the peripheral branches. (See Sciatica.)

NERVE INJURIES.

Treatment.—An important point in the treatment of nerve injuries is emphasized by J. Sherren.[11] The paralyzed muscles after a nerve injury, before and after nerve suture, must be kept relaxed by proper splints or apparatus, and their nutrition maintained by massage until the return of voluntary power renders these precautions unnecessary. Too often a wrist-drop, "claw-hand," or an arm deformed from brachial palsy is allowed to remain in the deformed position. The result is that the paralyzed muscles are overstretched, and when a perfect union follows a nerve suture the functional recovery will never be complete. In brachial palsy it is often impossible to judge by inspection what recovery, if any, has occurred, for the overstretched muscles do not act voluntarily. The deformity may thus persist, though electric stimulation by the interrupted current may show that nerve recovery has taken place. In the common type, upper-arm palsy, the arm should be bandaged to the side, the elbow supported, and massage and passive motion applied daily until recovery, or until the reaction of degeneration indicates the need of operation. After operation the same treatment is necessary.

In fractures of the humerus, if the *musculospiral* is injured at the accident, Sherren advises immediate operation, as it will usually be found that there is complete anatomic division of the nerve. If we delay, in the hope of spontaneous recovery, much valuable time is lost, end-to-end suture may be impossible, and the prognosis of secondary suture is not as good as that of primary suture.

THE FACIAL NERVE.

Nerve Anastomosis for the Cure of Facial Paralysis.—The length of time that the paralysis has existed is found not to have such an important relation to the functional result as was first supposed.

The associated movements of the face with the shoulder or tongue, or *vice versâ*, are found practically to disappear in the course of time; in many cases by a process of re-education of the centers. The question between the advantages of facio-accessory and of faciohypoglossal

anastomosis is still in dispute. Among the additional reasons for favoring faciohypoglossal anastomosis may be mentioned that the associated movements of the tongue are not visible if the mouth be kept closed, and the facial fibers which supply the orbicularis oris may take origin in the hypoglossal nucleus, according to Gowers.

Several more complete and more complicated operations for facial paralysis have been described. W. W. Grant[4] described the anastomosis of the facial and accessorius end-to-end, and then the anastomosis of the distal segment of the accessorius with the proximal end of the divided descendens hypoglossi, to avoid paralysis of the accessorius. But this substitutes for the latter the paralysis of the descendens noni which supplies the infrahyoid muscles, and but little is gained. A better method is that of Ballance, who makes an end-to-end anastomosis between the facial and hypoglossal, and then splits the accessorius, suturing the split off half with the distal end of the hypoglossal.

In the technic of the operation the parotid need not be disturbed if one hugs closely the sheath of the sternomastoid. The spinal accessory is found passing over (or just below) the tip of the transverse process of the atlas, the hypoglossal just beneath the tip and parallel with the digastric muscle. The point of anastomosis may be embedded in the belly of the sternohyoid muscle. The average time between the anastomosis and the first sign of the return of motion is estimated at about six months.[8] The observations of return of motion in thirteen or even seven days (Kennedy's case) appear to be erroneous, as a functional restoration of the axones in that time is a histologic impossibility.

As pointed out by J. Ramsay Hunt, the facial is probably a mixed nerve, the sensory root being represented by the nerve of Wrisberg, and its ganglion is the geniculate. The ganglion is of the spinal type and subject to inflammation (as herpes zoster) and degeneration (as in tic douloureux). The sensory zone lies within the external auditory canal, especially its anterior wall, and also includes the anterior of the auricle and the skin just in front of it. This zone lies between the trifacial in front and the cervical behind, and is also supplied by the auriculotemporal branch of the trifacial. Hence, it may not be easy to distinguish a facial from a trifacial tic douloureaux, especially when, as often happens, there is a reflex involvement of the trifacial. The latter must first be relieved by proper antineuralgic treatment. The only feasible cure for facial tic douloureaux is the division of the sensory root, the "pars intermedia" within the skull. This has been done and reported with an excellent result in one case by Dr. A. S. Taylor,[1] through a bone-flap opening extending backward nearly to the median line, upward 2 cm. above the lateral sinus, downward nearly to the foramen magnum, and forward into the posterior part of the mastoid. The facial motor root was also divided, but it reunited, as shown by the ultimate "almost complete return of power in the facial muscles."

BRACHIAL PLEXUS.

Brachial Palsies.—In a valuable contribution by Frazier and Skillern[3] a unique case of intradural avulsion of the anterior and posterior spinal roots of the brachial plexus is reported. In the 21 collected cases of rupture of the plexus without skeletal injury operated upon the rupture was between the transverse processes and the clavicle. In avulsion of the spinal roots the anterior are more likely to be torn than the posterior, hence the motor may predominate over the sensory symptoms if the nerve-roots are torn. In the diagnosis the pupillary phenomena—*i. e.*, contraction of the pupil, narrowing of the palpebral fissure, pseudoptosis, and sinking of the eyeball—are conclusive evidence, when present, of an intradural lesion at least of the first dorsal, and usually of the eighth cervical, roots, which give the ciliospinal fibers to the sympathetic. Their absence does not rule out an intradural lesion. If the serratus magnus, rhomboidei, and levator anguli scapulæ are paralyzed, the fifth and sixth cervical roots, either intervertebrally or just distal to that point, are certainly involved.

In the diagnosis of the position of the lesion causing these palsies Murphy[8] emphasizes a few points. The circumflex nerve is given off behind or just below the clavicle, so that an injury above the latter will involve the circumflex and also the musculospiral. As the pectoralis major receives a branch from both the external and internal cords of the plexus, complete paralysis of this muscle indicates a lesion of both these cords. If the diaphragm on the side involved is seen by the fluoroscope to be paralyzed, the roots of the plexus are divided at or within the foramina—otherwise beyond it, unless it is the result of a neuroma that may form at the ends of the torn roots or cords, in which case the neuroma should be excised.

Pathologically, two varieties of laceration of nerves are met with. In the first, the continuity of the nerve-trunk is not lost, but the ruptured fibrils are separated by blood-clot, the organization of which prevents their union. In these cases, if seen early, the proper treatment is longitudinal incision of the sheath and cleaning out the exudate. In the second variety the torn ends are separated. The possibility of an associated injury to the spinal roots may explain the unsatisfactory results of some properly executed sutures of the plexus.

Spontaneous recovery is rare, and should not be expected unless some improvement is observed within a few months. The sooner the operation is done, the better the chance of complete recovery. Delay in operating may account for some failures. After operation it may take years before the limit of recovery is reached, so that massage, passive motion, and electricity should be continued for months.

Sherren's[12] rule, that all subcutaneous nerve injuries which give the reaction of degeneration at the end of ten days should be submitted to operation, is an excellent one. If end-to-end suture is impossible, nerve anastomosis might be employed to relieve brachial palsies, either high up in the plexus or its roots, or lower down in the individual nerves.

When the entire plexus is ruptured so near the foramina that suture is impossible, a cross anastomosis may be made with a nerve on the sound side by Alexinsky's method. This was carried out by Babcock in one case with an encouraging result. In some of these cases intractable neuralgia is the prominent symptom. For this the sensory roots should be resected intradurally.

SCIATICA.

Treatment.—As in sciatica adhesions between the nerve-sheath and the parts about it are an important factor in causing the trouble, as shown by Bardenheuer, the injection of considerable quantities of inert, sterile substances about the nerve, between it and the surrounding parts, will break up these adhesions and cure the condition.

The injection of air by Cordier's method is well suited for this purpose.[5] This is pumped in by a rubber bulb of known capacity. In the tubing connecting the bulb with the needle a glass bulb, filled with sterilized cotton to filter the air, is inserted. The air is gently injected in several places along the course of the nerve at the seat of pain. A rounded swelling forms, over which the skin is at first blanched and then turns red. When the air reaches a nerve or vessel sheath, it spreads along it, forming secondary swellings. After the needle is withdrawn, and the puncture closed with collodion, massage must be employed, alternately scattering and bringing together the air, especially over painful parts. This massage should be repeated daily until the air is absorbed, which takes several days. No pain is felt, only a sense of distention or formication. Cutaneous sensibility is diminished at once. As much as 200 to 300 c.c. may be injected in the gluteal region. After introducing the needle, the operator should wait to see that no blood exudes, to assure himself that the needle has not entered a blood-vessel, to avoid the danger of air embolism. With this precaution the method is safe and simple, and good results are reported from its use.[5]

In the same way large amounts of salt solution, with or without the addition of an analgesic, have given good results. Schlösser has used alcohol (70 or 80 per cent.) injections in the treatment of sciatica, using small quantities at intervals of about five minutes. In 1907 he reported, at the German Congress of Internal Medicine, 38 cases, with relapses in only 2. Finkelburg reported experiments in which paralysis occurred when the injection was made into the substance of the nerve. He was of the opinion that, when good results were obtained, the injections had been made in the neighborhood of the nerve and not into it. This view was confirmed by the results reported by Fischler[2] from Erb's clinic. Four cases of complete paralysis of the external popliteal nerve, with reaction of degeneration, were reported, which stopped the use of this method in the clinic. In 3 out of the 4 cases motion was completely restored, but in the fourth case paralysis was still present eighteen months after the treatment. This only confirms what was stated above, that alcohol injections should not be practised in mixed nerves,

except in neuralgia of a stump and in the inferior maxillary division of the trifacial.

In the neuritic form of sciatica the nerve-sheath may become thickened and contracted and adherent to the nerve. To break up these internal adhesions the nerve is exposed, freed from external adhesions, and salt solution then injected through a fine aspirating needle, passed through the sheath and up or down within it. This is repeated eight or ten times, changing the direction or position of the needle. The nerve is seen to expand considerably. Massage is employed daily for ten days and the patient made to use the limb from the first.

NERVE SUTURE.

In *nerve suture* the nerve excitor may be very useful to identify the peripheral nerve segment. If muscle, fascia, or fatty tissue is not available to wrap around the sutured nerve, heterogeneous material must be employed, though it is inferior to homogeneous material. Among the former, not mentioned in Vol. II., p. 747, paraffin and oil of sesame (equal parts), paraffin and wax, or wax alone, spread out in the form of a thin tape, may be employed.

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CHAPTER CVIII.

TRAUMATIC NEURASTHENIA, TRAUMATIC HYSTERIA, AND TRAUMATIC INSANITY.*

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Little has been added to our knowledge of the subject of the traumatic neuroses during the last few years. However, in the study of traumatic hysteria, the important observations of Babinski[2] must be constantly borne in mind. Babinski regards the stigmata of hysteria as not infrequently the direct result of the medical examinations to which the patient has been subjected. Every examiner knows that in an hysteric subject he can develop symptoms almost at will. Involuntary and indirect suggestions may act as powerfully or even more powerfully than direct suggestion. Notably is this the case in the determination of the presence of anesthesias, local pains, and palsies. Further, it is well known that cases of hysteria are continually found to be worse upon repeated examinations. Old symptoms have been confirmed and new ones have made their appearance. Babinski holds, for instance, that one reason why hemi-anesthesia of the left side of the body is found so frequently is because the examiner, in making his test, employs his right hand, and naturally examines the left half of the body of the patient first. The mere fact of the question being asked as to whether the patient does or does not feel the impression of the esthesiometer or of the hand, as the case may be, is sufficient to provoke the anesthesia. While I am not convinced as to the entire truth of Babinski's position, I feel that examinations in traumatic cases in which claims for damages are made cannot be carried out with too much precaution. All of the examinations should be made in such a way that the patient does not know what is being sought for. For instance, if it be determined to elicit the symptom of spinal tenderness, the examination should be made in such a way that, while one hand is busy examining the spine, the other rests upon the abdomen or other portions of the body, the patient's attention being directed away from the hand upon the spine. Again, if a case of suspected hysteric hemiplegia be examined, it is the non-paralyzed side which should first be tested for sensation, and, if possible, the paralyzed side itself tested in such a way as to determine the presence of an anesthesia without the direct attention of the patient. Gross anesthesias will always betray themselves. It is only the hypesthesias and faint losses of sensation which will require the localized

* Supplementary to Chapter XXXIII., Vol. II., p. 759.

attention of the patient, and even here, with proper precaution, suggestion can be avoided. As a rule, the most difficult cases are those in which repeated examinations have previously been made by numbers of physicians.

A word is also necessary with regard to the tendon reflexes. As a rule, in traumatic hysteria, none of the tendon reflexes are modified except the knee-jerk. This is, as a rule, exaggerated. Even a disappearing patellar clonus may be noted in hysteric subjects. This is also true of the ankle-clonus. It seems unnecessary to point out that a persistent ankle-clonus almost always means organic disease and not hysteria. This is true invariably of the Babinski sign. When testing for the Babinski sign, however, it is of the utmost importance that the examiner should not allow the patient to know what motions of the toes, if any, he expects to elicit by his manipulation of the plantar surface. Upon a few occasions, when a number of examiners were present and the symptom was freely discussed in the presence of the patient, extension of the toes promptly took place, although the case was, beyond question, hysteric—*i. e.*, there is danger either of conscious or voluntary simulation or of a subconscious and hysteric simulation. The importance of a careful differentiation between hysteric simulation and organic disease is evidenced by a case placed on record by Rust.[11] He describes a case in which an hysteric patient three times simulated successfully a myelitis consequent upon a fall on the spinal column.

The tendon reflexes of the upper extremities and the jaw reflex do not present, as a rule, any modifications. Not infrequently an appearance of goose-flesh is noted when the patient's body, the back and buttocks for instance, are exposed or are handled. This is doubtless due to a reflex action of the erectores pilorum. It is, however, a symptom to which no special significance can be attributed. As already stated in the former article, tâche cérébrale is not infrequently noted in cases of traumatic hysteria. Joroschewsky[7] states that in traumatic neuroses there is in the first few months after the accident a white dermography, which increases for about one year, when it gradually disappears, giving place then to the red dermography. I have not noted this peculiarity.

Occasionally anesthesias of the mucous membranes are noted as in other forms of hysteria. At times there is anesthesia of the conjunctiva. In such instances it is not surprising to find occasionally also contracture of the visual fields, just as in an hysteric deafness there is often an anesthesia of the external ear.

The pupillary light reflex presents no special peculiarities, save that now and then a hippus is observed, *i. e.*, without there being any change in the degree of illumination; changes in the diameter of the pupil take place in rapid succession, *i, e.*, in an oscillatory manner. It is, as is of course well known, not an infrequent symptom of hysteria. Occasionally very curious hysteric phenomena are observed. Heveroch[6] observed 2 cases of traumatic neuroses, in which the right half of the visual field gave an impression of diminution in size of the object seen. Both patients had a right-sided anesthesia, with slight hemiparesis and

a concentric contraction of the visual fields. Heveroch also noted the association of this symptom with the difference in estimation of the size of the objects with the hand. In one of the patients the objects appeared to be much smaller when examined in the right hand than when examined in the left.

In the examination of a patient it is further of the utmost importance to note whether the patient has previously been addicted to alcoholism, excessive use of tobacco, or whether he presents the symptoms of an arteriosclerosis. Many persons who use alcohol or tobacco, or both, suffer from a more or less demonstrable toxic amblyopia, which surely it would be improper to ascribe to an accident, and, second, it is of the utmost importance that the physician should at his very first visit make a careful study of the vascular apparatus. It is known that in a small percentage of very severe accidents, accidents accompanied by profound physical shock, an arteriosclerosis may develop, but this arteriosclerosis is very slow and late in its evolution. If, therefore, a patient examined immediately or shortly after an accident presents at the time the evidences of arteriosclerosis, that arteriosclerosis must have had a previous origin—*i. e.*, an origin independent of the trauma.

Schlesinger[14] and others are of the opinion, in which I myself join, that many traumatic cases have been previously sufferers from disease of the internal viscera and, indeed, of the nervous system long before the accident, and that, therefore, an accurate past history, as well as an exhaustive examination at the earliest possible moment, is necessary. Of course an hysteria can readily be superimposed upon a pre-existing disease, but nevertheless the distinction is important, as in the case of Schultze,[15] in which an hysteria was superimposed upon a pre-existing epilepsy.

Again, in rare cases, a phosphaturia is noted in a traumatic neurosis. It is exceedingly probable that such a phosphaturia has existed previously and is not due to the trauma. In my own experience it is an excessively rare symptom, though Orlowski[9] reports a number of cases.

Hysteric deafness is not at all infrequent, and, as the following case (Hammerschmidt[5]) illustrates, it is frequently accompanied by hemianesthesia of the same side of the body. A soldier, standing close to a file of soldiers taking part in rifle practice, suddenly became deaf in the right ear after the first volley. The difficulty of hearing increased, and paresis of the right auditory nerve following labyrinthine shock was diagnosticated. The drum-head was not damaged. Later, a fully developed right-sided hemianesthesia with flaccid right-sided palsy made its appearance. Hammerschmidt regarded the prognosis as unfavorable, for what reason it is difficult to understand, as the case appears to have been one of hysteria.

In regard to the mental diseases which may follow trauma, we may have, as has been pointed out in Chapter XXXIII, Vol. II., the depressive state which may accompany neurasthenia and hysteria. A true melancholia is not dependent upon trauma, and this is true of the other members of the manic-depressive and paranoid groups. Delirium,

mental confusion, and stupor may follow severe blows, traumata of the head. Sommer[16] believes that the Korsakow symptom group is frequently observed after trauma. This has not been my own experience. Indeed, I am inclined to suspect that cases in which this symptom-complex occurs have previously been sufferers from alcoholism.

The relation of the accident to the special symptoms that are developed is always an interesting study. It is not infrequently the case that the part injured, say a limb, becomes a subsequent seat of an hysteric palsy, contracture, or other hysteric symptoms. There is at times a natural history, as it were, between the accident and that which follows, such, for instance, as the development of an hysteric blindness in an eye which had been struck a glancing blow by a falling electric-light bulb.

Whether, as Goetze[3] thinks, the conditions present are directly related to the degree of disturbance of the consciousness at the time of the accident, or of the degree of the emotional effect, is problematic, and really leads to no direct practical result. The suggestion of Grunewald[1] is of more value, namely, that in traumatic hysteria the trauma plays the rôle of a hypnotic factor, for which reason the symptoms are always centered upon the portion of the body injured. He holds that proper medical attendance, as well as early dismissal of the patient from hospital care, will tend to prevent the subsequent development of the symptoms.

Recent literature has added little to the subject of prognosis, so important from the legal point of view. It is very significant that in Germany, in which country a policy has been adopted of paying sick benefits to the injured party (for example, a workman) at regular and stated intervals, recoveries are very infrequent, and the vast majority of cases are greatly prolonged and delayed. Indeed, the expression "Rentenhysterie," which may be freely translated into "sick benefit hysteria," has become quite a well-known term in Germany. Physicians whose duty it is to examine these patients have expressed themselves freely upon the subject. For instance, Mendel[8] describes the symptomatology of 4 cases of what he terms "neurasthenia querulatoria." The last, he points out, is not the result of the accident, but of the accident insurance law. By this he means the mental state which persists after the symptoms properly attributable to the accident have disappeared. He points out that the physician must be prepared to meet with outspoken simulation and marked exaggeration. Indeed, he himself discounts the complaints of the patient 50 per cent. He is further of the opinion that the neurasthenic symptoms, as a rule, do not present a hindrance to work; that work, indeed, is the best curative agent.

Sachs,[12] after a thorough investigation of the subject, goes so far as to express the opinion that cases of the traumatic neuroses ought not to be permitted to become the subjects of sick benefits, that this would be the most radical method for preventing their occurrence and their development following accidents. Sacki[13] also dwells upon the

importance of the early return of the patient to work, especially to the work to which he is accustomed.

Rigler's[10] recommendation for dealing with traumatic cases is hardly applicable to the conditions obtaining in this country. He recommends, first, diminishing as far as possible in the mind of the patient the advantages to be derived from pecuniary compensation; second, abridgment and simplification of the method of dealing with these patients, and, finally, suitable employment. In many cases he believes it will be wise to give a gradually reducing amount of sick benefits, and, finally, none at all.

The plan proposed by Akerman,[1] of giving a delayed answer in damage cases, *i. e.*, waiting for one or two years, cannot be recommended. It, of necessity, brings about a prolongation of the symptoms. As far as my own experience goes in cases of pure traumatic hysteria, the symptoms rapidly subside after litigation has been disposed of. If there be an underground of true neurasthenia, the symptoms of the latter may persist for some time, but they, too, eventually disappear.

That there is in traumatic cases in which there is an opportunity for claim for compensation an undue prolongation of symptoms, there can be no question—a prolongation of symptoms such as is found under no other circumstances. While it is true that in some cases this prolongation is subconscious and involuntary, and is maintained by the long-continued suspense with regard to the outcome of litigation, there can be no doubt that in many other cases again there is a tendency to malingering, a malingering that does not hesitate at gross exaggeration, and is alike shameful and shameless.

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CHAPTER CIX.

SURGERY OF THE SPINE.[1]

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Spina Bifida.—Indications for Operations.—If the spina bifida is below the eleventh dorsal vertebra, and hence involves the tip of the conus or the cauda equina, operation is indicated, even in the presence of the loss of sphincteric control and of partial paralysis of the lower extremities. For here regeneration may take place in the cords of the cauda equina. This is the most common position for a spina bifida. Murphy advises, and has practised, resection of any cicatricial or atrophied portions of the cauda with end-to-end suture. This applies in syringomyeloceles and in myelomeningoceles.

Greenberg[2] has reported operation on a case of lumbar spina bifida, sixteen years of age, which resulted in regaining control of the bladder and rectum. The caudal filaments were replaced within the canal without resection. Operation above the twelfth dorsal vertebra can offer little or no hope of motor improvement.

Tumors of the Vertebræ.—To the varieties given of tumors of the vertebræ three rare cases must be added. Brewer[3] reports a unique case of blastomycosis of the vertebræ, with two separate foci in the spine and laminæ of the third dorsal vertebra and in two or three of the upper lumbar spines. Two operations were done, and the man has remained well.

J. K. Young[4] reports a case of actinomycosis involving the tenth dorsal vertebra. A case of large hydatid cyst, involving the fourth and fifth lumbar vertebræ, is reported by Theobalds.[5]

Intraspinal Tumors.—Unlike vertebral tumors, these are usually primary and mostly benign, though microscopically a large percentage of them were formerly classed as sarcoma.

Symptoms.—According to Murphy[6] the root pain can be excited by pressure upon the cutaneous segment corresponding to the cord segment involved. Bruns refers the segmental root pains to a compression of the segment from which the root springs, and not to pressure upon the root in its intraspinal course. This clinical law has an im-

[1] Supplementary to Chapter XXXV., Vol. II., p. 816.
[2] New York Med. Jour., March 30, 1907, vol. xlviii., No. 13.
[3] Annals of Surg., Dec. 1908.
[4] Amer. Jour. Orthoped. Surg., Nov., 1908.
[5] Lancet, April 10, 1909.
[6] Surg., Gyn., and Obst., April, 1907.

portant bearing on localization, and renders the initial root pains of the first importance in the niveau-diagnosis, the diagnosis of the level or segment at which the tumor lies. Limitation of movement, active and passive, of a small segment of the spine corresponding to the tumor may be noted, but requires careful observation to detect.[1] In my own experience vertebral symptoms are usually absent. When present they may be deceptive, as localizing factors, if employed independently of neural symptoms. In cases of extramedullary tumor in the cervical region Hunt[2] has repeatedly observed a distinct girdle sensation or constriction in the umbilical or lower thoracic level.

Differential Diagnosis.—*Tuberculosis* is more common as a cause of compression of the cord than tumor. Tuberculin tests, and especially the *x*-ray, may be of great value in diagnosis, as the latter will always show the lesion or the deformity.

The Wassermann reaction is of great service in the diagnosis of suspected *syphilitic* lesions. Röpke,[3] as the result of a single observation, thinks that a yellow color and a high percentage of albumin in the cerebrospinal fluid is of importance in the differential diagnosis of intradural tumors. *Pachymeningitis hypertrophica cervicalis* may closely resemble intraspinal tumor in the nature and sequence of its symptoms. In its third stage—*i. e.*, that of compression—its progress may be very slow, even up to twenty years, and its origin is usually syphilitic. Hence, the Wassermann reaction is of great value. The disease involves chiefly the region of the cervical enlargement, and there is great stiffness of the neck in the early stages. *Myelitis* is usually very rapid in its development in acute cases, and chronic myelitis is often syphilitic. There is, as a rule, no pain in pure myelitis. *Circumscribed serous meningitis* (Krause) cannot be differentiated from tumor, but requires the same treatment. It may occur primarily, but occasionally accompanies chronic affections of the cord (Oppenheim).

When a differential diagnosis cannot be made, the patient should receive the benefit of the doubt, and an exploratory laminectomy be made without delay.

Extra- and Intramedullary Tumors.—In intramedullary tumors upward extension of the sensory and motor paralysis is often observed, rarely in extramedullary growths except by one or possibly two segments. In central growths, especially gliosis and glioma, vasomotor and trophic disturbances frequently occur, also a spinal deformity (kyphoscoliosis) without pain or tenderness. In the dissociated anesthesia, sometimes observed in extramedullary growths, Hunt[4] has observed that the tactile sense, while present, is definitely obtunded when compared with a normal area, which is not the syringomyelic type of dissociated anesthesia. Atrophic palsy, corresponding to an extensive longitudinal involvement of the cord, is very characteristic of central

[1] Murphy, Surg., Gyn., and Obst., April, 1907.
[2] Hunt and Woolsey, Annals of Surg., Sept., 1910.
[3] German Surg. Cong., 1911.
[4] Hunt and Woolsey, Annals of Surg., Sept., 1910.

tumors. Fibrillary twitchings occur with this, but also with posterior extradural tumors. If root pains occur in central growths, they do not precede the paralysis by so long an interval. If there is any doubt as to the position of the tumor, here again the patient should be given the benefit of the doubt, and exploration made.

Treatment.—The use of the Wassermann reaction may save valuable time in the treatment of a supposedly syphilitic condition by excluding that diagnosis. As Crowe[1] has shown that urotropin is excreted into the cerebrospinal fluid, 15 grains of this drug should be given shortly before the operation, as its maximum concentration in the fluid occurs from one-half to one hour after its ingestion. On account of its inhibitory effect on the growth of organisms in the cerebrospinal fluid and the urine, 30 grains or more should be given daily, in divided doses, until the wound is healed and catheterization is unnecessary.

Laminectomy.—Murphy[2] advises the conical drill or burr to perforate the laminæ at the base of each transverse process. It is only necessary to employ it at one lamina. The Hudson drill may be used instead.

Elsberg[3] advises the two-stage method in operations for tumor in the cervical region and in subpial and intramedullary growths. At the first stage he advises the opening of the dura and, if the growth is subpial, a small incision in the pia, and in true localized intramedullary growths a small longitudinal incision of the pia and the cord, in the posterior median column, a few milimeters external to the posterior median fissure, where the tumor is nearing the surface of the cord, with the expectation that at the second operation, a few days or a week later, the growth will be found extruded from its bed, and readily removable with a minimum of danger to the delicate structures of the cord. This was beautifully illustrated in the two cases he reports, which were apparently intramedullary growths. If the growth is subpial or intramedullary the dura may be sutured at the end of the first stage, otherwise not, but the muscles and skin should be carefully sutured, without drainage in any case. The principle of allowing the gradual extrusion of the growth appears to be a valuable one in facilitating an easy and safe removal of subpial and intramedullary growths. It may be applied in all parts of the cord in such growths and in other parts of the cord than the cervical in all intradural growths. Thus Elsberg[4] has applied it very successfully in several cases of large tumors of the cauda equina connected with many of the nerve-roots of the cauda. These tumors have given a history of progressive symptoms for one to two years of pain in the back and lower extremities, loss of power (especially drop-foot) and sensory disturbances in the latter, loss of ankle- and knee-jerks, etc. After their extrusion they are removed with comparative ease at the second operation. Unless, however, there

[1] Johns Hopkins Hosp. Bull., 1908, vol. xx., No. 217.
[2] Surg., Gyn., and Obst., April, 1907.
[3] Jour. Amer. Med. Assoc., April 16, 1910, vol. liv., pp. 1908, 1909; Amer. Jour. Med. Sci., Nov., 1911, p. 636; Annals of Surg., Feb., 1912, p. 217.
[4] Annals of Surg., Feb., 1912, p. 217.

are distinct advantages, such as those cited in Elsberg's cases or the decrease of the shock, the increased risk of wound infection alone is enough to decide the question in favor of the one-stage operation. Unfortunately, most intramedullary growths are not strictly localized and, therefore, not removable. E. Bramwell reports that he has been able to find but one case in literature where an intramedullary tumor was successfully removed. Röpke reported the successful removal of such a growth at the 1911 Congress of German Surgeons.

A. S. Taylor[1] thinks hemilaminectomy gives ample room for the removal of intraspinal tumors in many cases. In large tumors, by exposing its exact size and location, the operator is enabled to remove just enough of the opposite laminæ for the easy extirpation of the tumor. The loss of the bony protection of the cord is thus minimized. It readily allows the exploration of the anterior surface of the cord.

There is no object in *suturing divided posterior nerve-roots*, as they do not regenerate, and the division of less than three does not cause anesthesia (Sherrington's law). If the tumor grows from them they should be resected.

The *mortality* is constantly diminishing. Among 9 operations for intraspinal tumor and 3 exploratory operations by myself, the mortality has been only 8.33 per cent., and *recurrence* has been the exception. One patient died over a year after operation, with probable recurrence, one case of extradural tumor recurred within a year, but, after a second operation, she is well five years later. Otherwise no recurrence occurred.

The **division of the posterior nerve-roots for pain** has been more employed than formerly, having been extended to the treatment of gastric crises in tabes. The results in tabes have not been altogether satisfactory. This has been attributed to the difficulty of the proper selection of cases and of the roots to be resected. Generally three or four of the thoracic nerve-roots, from the sixth to the twelfth, have been resected, as these are connected with the splanchnic nerves passing to the semilunar ganglion. Several cases are reported as cured. The difficulty in these operations for the relief of severe pain is one of diagnosis, *i. e.*, to determine the site of the lesion. The operation is most beneficial in the peripheral type of pain, and can be of no use where the lesion is central to the point of section.

Resection of Posterior Spinal Nerve-roots for Spastic Paralysis and Athetosis.—The spastic paralysis may be due to a cerebral hemiplegia, diplegia, or paraplegia, or to so-called Little's disease, a congenital spinal spastic paralysis. This is the most recent development in the surgery of the spinal cord. First suggested by Spiller[2] in 1905, it was advocated by Förster[3] in 1908 and in 1909, whose articles report the first operations in this field by Prof. Tietze, of Breslau.

[1] Annals of Surg., April, 1910.
[2] Jour. of Ment. and Nerv. Dis., May, 1905.
[3] Zeitschrift für Orthopädische Chir., Bd. xxii., 1908; Mittheilungen aus. d. Grenzgeb. d. Med. u. Chir., Bd. xx., No. 3, p. 493, 1909.

Other reports of operations by Gottstein, Frazier,[1] Taylor,[2] and others followed.

An organic lesion in the motor tracts causes a twofold motor disturbance: (1) a weakness and (2) a contracture of various muscles, depending upon the site and extent of the lesion. The lesion not only interrupts motor impulses from the brain, causing paresis, but also the inhibiting or controlling influences of the cortex on the spinal reflexes. Hence, the latter are exaggerated, and the joints become fixed in an abnormal contractured position, and voluntary motion is resisted by reason of the pathologic condition, called " spasticity."

Spasticity is thought by many to be a reflex process, originating in peripheral sensory impulses from the skin, joints, muscles, etc. This reflex, which normally promotes a certain amount of fixation by the delicately balanced resistance between the extensor and flexor muscle groups in all joint movements, produces an excessive joint fixation and muscular resistance when the cortical inhibition is diminished.

The heightened reflex irritability is shown in the spastic syndrome of increased knee-jerk, ankle-clonus, Babinski, etc. The greater the loss of voluntary motion, the greater, as a rule, is the reflex activity. If a motion is made, actively or passively, it throws the limb, and often the opposite limb as well, into a series of " associated movements." Athetosis is also sometimes present, especially in cerebral palsies. In time muscular contracture may occur, shortening the spastically contracted muscles (flexors and adductors), so as to require tendon lengthening to allow the joints to be fully extended. Little or no voluntary motion is possible, owing to the spastic fixation of the joints, the associated movements, and the muscular contractures. If the patient can walk at all, it is by a cross-legged progression.

If the spastic condition is a reflex disturbance the rational treatment is to remove a link in the chain of the reflex arc. The motor portion of the arc cannot be broken without causing paralysis; most of the sensory nerves are mixed nerves, and must be left intact for the same reason. Hence, there remains only the posterior or sensory nerve-roots as the point of attack.

Technic.—Most operators do an ordinary laminectomy. Frazier[1] has shown that a lamina, or a part of a lamina, may sometimes be left between the two pair of roots resected. Taylor[3] has devised, employed, and recommended hemilaminectomy, giving as its advantages minimum loss of blood and of the bony protection of the cord, and no postoperative deformity or loss of flexibility of the spine. The incision, just to one side of the spine, is carried down to the laminæ, which are exposed by an elevator out to the articular processes. A lamina is perforated by a Hudson burr and the remaining laminæ removed by a rongeur with a flat lower blade. The sides of the opening are then bevelled in a forward and mesial direction by a special bone-cutting forceps. The width

[1] Surg., Gyn., and Obst., Sept., 1910.
[2] Clark and Taylor, New York Med. Jour., Jan. 29, 1910.
[3] Annals of Surg., April 1910.

of opening obtained is 1.8 cm. in the cervical, 1 cm. in the dorsal, and 1.5 cm. in the lumbar regions. The dura is divided in the middle of the opening, the side of the cord is well exposed, and its anterior surface may readily be explored. The approach is claimed to permit resection of the nerve-roots on both sides without injury to the cord. But in most of Taylor's cases the nerve-roots of but one side were divided, and in one case[1] he found it impossible to resect the roots on the opposite side in the lumbar region. Frazier[2] thinks this will be the experience of most operators in the lumbar region, which, in muscular subjects, lies far below the surface, and it is here more difficult to identify the roots and still more to distinguish the posterior from the anterior. It is much easier to expose the cord in children than in adults, and in the cervical than in the lumbar region.

It is not always a simple and easy matter to identify the nerve-roots, even with a large exposure. Mistakes have been made and anomalies occur. The identification is made by their point of emergence from the dural sac, and perhaps the stimulation of the corresponding anterior root may be of assistance. When one is identified the others may easily be distinguished. To identify the roots, and to separate the posterior from the anterior roots, a dry field and ample exposure is required.

The two-stage procedure is not to be endorsed, on account of the added risk of infection and of a second anesthetization. Frazier[2] found that it was not possible to distinguish and separate the small artery accompanying the posterior roots. All needless trauma of the cord should, of course, be carefully avoided, the dura sutured without drainage, and urotropin administered.

A most important consideration of the technic is the selection of the roots to be resected. As each muscle or muscle group is supplied by three spinal segments and as many roots, and the cutaneous supply of a given region is derived from at least three roots (Sherrington), we plan to break the reflex arc of the affected muscles by dividing at least two of the three roots from which the muscles derive their sensory supply. We may reasonably suppose that the sensory supply of the affected muscles is derived approximately from the nerves supplying the overlying zonal areas of skin. If every source of sensory stimulation were removed a condition of anesthesia and flaccidity would be substituted for one of spasticity. As there are seven roots to be considered in spasticity of the lower extremities—*i. e.*, all the lumbar and the first two sacral—Förster's first dictum was that at least four roots should be sacrificed. The general rule has been not to divide more than two successive roots.

But Taylor[3] has resected six successive roots on one side without anesthesia, and seven successive roots without loss of reflexes. On the other hand, unexpected disturbance of sensation has occasionally developed after section of only two roots, so that our ideas of the

[1] J. J. Morehead, New York Med. Rec., May 14, 1910.
[2] Surg., Gyn., and Obst., Sept., 1910.
[3] Clark and Taylor, New York Med. Jour., Jan. 29, 1910.

segmental distribution of the roots may have to be revised. Just what roots, and how many, should be resected to gain the desired result is not definitely settled. But whether it is possible to divide six or seven successive roots without lasting disturbance of sensation or reflex, it is certainly true that the resection of four out of seven will accomplish the desired result.[1] If too few roots are sacrificed the result will not be satisfactory. Several combinations of four or three roots resected have given satisfactory results.

Effects of the Operation.—For several days or even weeks shooting pains will be suffered, and the muscles and tendons will be very tender on every attempt at motion. This pain and tenderness will completely disappear when the degeneration of the severed posterior roots is complete. The reflexes may be abolished at first, to be partly or completely restored later.

Results.—In most cases the spasticity is relieved, whether of long standing, of severe type, of spinal or cerebral origin, and in both adults and children. The annoying reflex associated movements are likewise usually abolished and the exaggerated reflexes become normal or are diminished. Sensation is not seriously disturbed and athetosis is entirely relieved. Voluntary motion has been restored in over half the cases reported. This may be limited by muscular contractures, requiring tendon lengthening, etc., the results of which are now permanent and not temporary, as before the root section. In every lesion of the pyramidal tracts there is more or less muscular weakness, which is so masked by the spasticity that one cannot accurately foretell before the operation how much loss of voluntary motion there will be.

The restoration of voluntary motion does not necessarily imply the return of useful function. The patient may be able to move the various joints, but not to stand or walk. In this lack of useful function weakness plays a part, but an important factor is that the patient, who has never walked or not for years, requires systematic and continued education in the functional use of the affected limbs, under the direction of a competent person. This may be made more difficult in some cases by the existence of mental impairment. The prognosis is less favorable, therefore, in congenital cases. The results, as regards the functional use of the affected limbs, have been rather disappointing so far, but sufficient time may not yet have elapsed to attain the final results. The good effects of the operation are permanent, which was not the case with all the former plans of treatment, tenotomies, etc.

The operation is *indicated* in degenerative pyramidal lesions with severe spastic palsy, cerebral as well as spinal. Each case must be carefully studied to determine the prognosis.

The *mortality* will depend very largely upon the general condition of the patient.

Fractures of the Spine.—Eight cases of **isolated fracture** of the *lumbar transverse processes* have been recently reported,[2] due to forcible

[1] Frazier, Surg., Gyn., and Obst., Sept., 1910.

[2] Ehrlich, Zeit. f. Chir., 1908, No. 2. M. Gallez, Presse Méd., Oct. 6, 1909. S. Lange, New York Med. Jour., Oct. 9, 1909.

lateral flexion from falling rock, severe strain, a direct blow, etc. Three were diagnosed by the *x*-ray after several months of persistent symptoms due to non-union. The symptoms are slight swelling, localized pain on pressure or on movement, especially toward the injured side, relieved by lying down, and muscular rigidity. The fracture itself is of minor importance, but its recognition as a cause of the above symptoms, which may become chronic if not properly diagnosed and treated, is of great importance. The history of the injury, and especially the *x*-ray, lead to the diagnosis. Many such cases, which would now be recognized by the *x*-ray, have doubtless been overlooked and considered as only sprains.

In *compression fractures* of the vertebral bodies, as a result of the greatest pressure being exerted anteriorly, the intervertebral disc, together with bony detritus, may be forced backward so as to press against the anterior aspect of the cord.

In none of the fractures of the odontoid process collected by Gurlt was the ligamentum transversum dentis torn. In these cases injury of the medulla, when it occurred, was due to the backward pressure of the lower odontoid fragment.

In fractures of the spine the " irreparable damage to the cord " is caused at the moment of impact of the displaced vertebræ, the force of which is invariably greater than that due to the continued pressure of the fragments which are supposed to compress the cord. Continued external compression of the cord has very little to do with the cord lesion. Removal of extramedullary clots are of doubtful value. If a fragment has exerted pressure sufficient to cause degeneration, that degeneration will take place and be as immutable one second as one week after the injury.[1]

Operative Treatment.—In the cases of partial injury to the cord, including cases of hematomyelia, operation is often unnecessary, and will not benefit unless there is continued compression. There is no known means of determining the existence of continued compression, except by the degree of displacement of the spinous processes, the *x*-ray, or laminectomy. The latter is the surest.[2] If the laminæ are fractured, or there is a considerable deformity to be reduced, operation is indicated to prevent further injury and to allow the most satisfactory reduction of the deformity. I have seen a patient with fracture of the laminæ, without symptoms, develop marked paralysis in a transfer between two hospitals, lying on his back in an ambulance.

In the severe cases it is certain that operation can do nothing for complete crushes of the cord, in which there is an immediate, complete annular paralysis of both motion and sensation. But we cannot at the outset, in every instance, distinguish these cases from cases of severe partial crush, in which the paralysis will improve considerably in time. Several cases of this kind have been operated on with a good result, but the result is rarely due to the operation. Equally good and unexpected

[1] A. R. Allen, Jour. Amer. Med. Assoc., March 21, 1908.
[2] Murphy, Surg. Gyn., and Obst., April, 1907.

results follow expectant treatment, as I have experienced. A real cause of continued compression that is removable is seldom found on operation; the latter is merely exploratory.

Such cases, however, encourage one to continue operating, in the hope that some time one may encounter a case that can be helped. The considerable number of complete crushes encountered in this endeavor dishearten the surgeon, as so little hope of benefit to the patient can be held out before the operation and often none afterward.

If there were only something that could be done in the severe, but not complete, crushes that would aid in the recovery of the patient, and make it more complete, operation would be more definitely indicated in the severe type of spinal injury. The experiments of A. R. Allen[1] suggest the hope that something may be done with this end in view. He considers it " a very uncommon occurrence to find a passive impingement of bone on the spinal cord when the operation of laminectomy is performed for fracture dislocation," and this opinion is borne out by common experience. Hence, to account for the " cessation of function in the spinal cord in those cases in which the cord has not been literally cut through," he assumes that there must be either (1) a " destruction of axis-cylinders directly due to the impact," or (2) " an edematous and hemorrhagic outpouring into the cord tissue which, by its pressure and chemical activity, inhibits temporarily all conduction function or destroys permanently the spinal cord." The first, or destructive, lesion is beyond our reach; only the second, " the heightened intramedullary pressure," might perhaps be ameliorated.

In experiments on animals with measured impact on the spinal cord Allen found that if the impact exceeded a certain degree serious symptoms, not recovered from, developed. A little greater impact produced symptoms of complete transverse lesion. He also found that a median longitudinal incision, 2 to 3 cm. long, of the normal cord, made by a very thin knife, caused no symptoms of note. Further, after a measured impact, which would ordinarily cause a symptom-picture of complete transverse lesion with a fatal result, a median longitudinal incision completely through the cord is followed by a considerable outpouring of blood and serum from the cord substance and the complete restoration of motor power.

How long after an injury the longitudinal incision will still effect a good result is a matter to be determined; if only for a short time, the method would only be applicable in a few favorable cases, seen at once. This method has not been tried on the human subject, but, in view of the unsatisfactory and negative results with present methods in severe but not complete crushes of the cord, if further experiments confirm the results, the following course of treatment suggests itself, with the hope of yielding improved results: Laminectomy at the earliest possible moment; exact median longitudinal incision of the cord with a very fine knife through the area of impact, if the cord is not completely severed, to drain the products of edema and hemorrhage from the in-

[1] Jour. Amer. Med. Assoc., Sept. 9, 1911.

jured tissues. If the pia is found widely torn this procedure would probably be of little use, but it is not usually torn in incomplete lesions. At the same time, any cause of continued compression may be relieved in the exceptional cases where such is found. It is useless to attempt to suture the cord.

In all injuries involving the cauda equina operation is indicated. The posterior, as well as the anterior, roots are provided with a neurilemma sheath, and are capable of regeneration—at least up to the posterior commissure. Murphy believes that after regeneration the sensory roots may regain functional connection with the posterior horns of gray matter. Hence, suture of the fasciculi of the cauda, posterior as well as anterior, is imperatively indicated. Up to the seventh day after injury the distal segments of the right and left fasciculi of the anterior roots of the cauda can be distinguished by their response to the faradic current. The point of suture may be surrounded by egg-membrane if the dura cannot be closed by suture.

CHAPTER CX.

SURGERY OF THE HYPOPHYSIS (PITUITARY GLAND).[1]

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Lesions of the hypophysis and the clinical syndromes associated with them have assumed a new interest for the surgeon since the feasibility of removal of tumors of the gland has been demonstrated.

Before discussing the symptoms of hypophyseal disease it will be necessary to review at some length the embryology, histology, physiology, and pathology of the gland, for recent investigations in these branches have led to a simplification of the classification of tumors of the hypophysis, have established an anatomic basis for acromegaly, and have explained many clinical phenomena which before were not at all or but little understood.

Embryology and Histogenesis.—The hypophysis develops from two anlage. One of these is an evagination from the floor-plate of the telencephalon, which gradually elongates to form the posterior lobe and infundibulum, while the other is an evagination of mucous membrane from the buccal cavity, known as Rathke's pouch, which appears in the human embryo during the fifth week. When these two anlage come in contact a concavity is formed in the wall of Rathke's pouch, in which the posterior lobe and infundibulum lie.

The pouch of Rathke is at first in free communication with the pharyngeal cavity, but as the pouch grows away toward the base of the brain the connection is rapidly reduced in size by the formation of the cartilaginous base of the skull until it is nothing but a tubular stalk, or later, when the lumen is lost, an epithelial cord. In most cases the connecting epithelial strand disappears entirely, and the pouch of buccal epithelium, from which the anterior lobe develops, loses all connection with the pharyngeal wall. In some cases a bony canal which passes obliquely upward and backward through the body of the sphenoid indicates the course which the hypophyseal vesicle has traveled in reaching its final position in the sella turcica. When this—the craniopharyngeal canal—persists, ectopics of hypophyseal tissue and anomalies of development of the hypophysis may occur. Suchanek has reported a case in which the hypophysis was found in the craniopharyngeal canal and not in the sella turcica, and Erdheim has reported a case of acromegaly in which the hypophysis occupying the sella turcica was normal, but a malignant adenoma was found in the body of the sphenoid.

Pharyngeal Hypophysis.—The pharyngeal end of the tubular stalk or epithelial cord, which originally connected the hypophyseal vesicle with the pharynx, does not become involuted, as was considered to be the case until recently. From it develops fully differentiated tissue which differs in no way histologically from that forming the anterior lobe of the hypophysis. Erdheim was the first to describe, under the mucous membrane of the vault of the pharynx in the newborn, islands and strands of tissue which histologically corresponded to that composing the anterior lobe of the hypophysis. This tissue forms the pharyngeal hypophysis, the pathologic significance of which will be discussed later. Haberfeld examined 51 subjects, and in all has found this hypophyseal tissue in the vault of the pharynx.

The pharyngeal hypophysis usually lies in the median line, at the point where the nasal septum borders on the pharyngeal vault, in the dense connective tissue

[1] Supplementary to Chapter XXXVI., Vol. III., p. 17.

lying between the mucous membrane and the bone. In the adult it is found directly beneath the mucous glands lying in the connective tissue, while in the embryo and newborn it lies directly beneath the surface epithelium. It is obliquely placed, its position corresponding to that of the craniopharyngeal canal, which, when present, passes from below and in front, upward and backward.

The size of the pharyngeal hypophysis varies with age. It enlarges until middle life, when it becomes stationary and remains of the same size. In the embryo it measures 3 mm. in length, in the newborn 4 mm., and in the adult 5 mm. In width it varies from ½ to 1 mm.

The pharyngeal hypophysis may have the form of a cord which, especially in the embryo and newborn, may be irregular, being constricted at different points. It may have the shape of the letter S. There is no capsule in the embryo and newborn, but in the adult the connective tissue surrounding it is thicker and condensed to form what might be called a capsule. The alveoli which are found in children and adults are small and round or oval in form. Some of these in adults contain colloid. The tissue presents all the histologic features of the anterior lobe of the hypophysis occupying the sella turcica. The pharyngeal hypophysis is to be regarded as an actively functioning gland, rather than a rudimentary or involuting one.

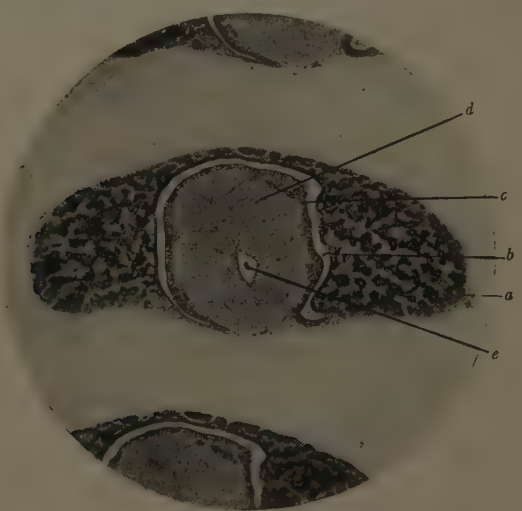

FIG. 108.—FRONTAL SECTION THROUGH THE HYPOPHYSIS OF A FETAL PIG MEASURING 5 CM. (Lewis.)
a, Large anterior lobe composed of branching columns of cells invading a vascular mesenchyme; *b*, hypophyseal cleft, remains of the cavity of the original hypophyseal vesicle; *c*, pars intermedia, investing the posterior lobe and infundibulum; *d*, pars nervosa; *e*, infundibular canal.

When the sphenoid develops the epithelial cord disappears and the hypophyseal vesicle loses all connection with the pharynx, becoming included within the skull. In studying the development of the hypophysis and the differentiation of the various cells entering into its structure much more can be learned from some of the lower forms, such as the pig, than from man, for in the latter the processes of differentiation are so complex that it is often difficult to trace the different elements through their phases of development. In Fig. 108 is seen a coronal section through the hypophysis of a fetal pig measuring 5 cm. The part of the vesicle applied to the infundibulum and that distal to it develop differently.

The cells upon the free surface of the vesicle multiply rapidly to form the large cellular anterior lobe. They form interlaced and branched columns which invade a vascular mesenchyme. By the rapid growth of the cells forming the anterior wall the cavity of the vesicle, which originally was relatively large, is reduced to a small cleft, which, as we shall see later, is the line of cleavage followed in separating the anterior and posterior lobes.

The epithelium of the juxtaneural portion of the hypophyseal vesicle does not proliferate so rapidly as that lying anterior to the cleft. This layer of epithelium, which is differentiated early and remains thin, becomes the pars intermedia, which at the margins of the cleft becomes continuous with the cells of the anterior lobe.

The arrangement in man is not as simple as that just described in the pig. In the newborn the cleft is broken up, for the juxtaneural epithelium becomes infolded to form colloid vesicles, the cavities of which may be regarded as parts of the cleft which have been surrounded by the infolding epithelium. Parts of the original cleft may be seen in the human newborn which are bounded posteriorly by layers of epithelium which belong to the pars intermedia. In the adult this epithelium is found broken up into masses or islands of epithelial tissue which invade the nervous portion of the posterior lobes. This tissue, we believe, to be a derivative of the pars intermedia, the epithelial investment of the posterior lobe, although Erdheim, Löwenstein, and others believe it to be anterior lobe epithelium which has invaded the nervous substance of the posterior lobe.

Three types of mammalian hypophysis are found. In man, monkey, ox, pig, and rabbit the body and neck of the posterior lobe are solid, but occasionally traces of a cavity may be found in the neck. In this type the pars intermedia does not invest the posterior lobe so completely as in those about to be described. It is most abundant around the neck of the posterior lobe and spreads over and on to the adjacent surface of the brain. In the dog the body of the posterior lobe is solid, but the neck is hollow and communicates with the third ventricle. In this type the posterior lobe is almost completely surrounded with epithelium. In the cat the posterior lobe is hollow and its cavity is in free communication with the third ventricle, while the epithelium affords almost a complete investment for the posterior lobe.

Anatomy.—The hypophysis lies in the sella turcica. It is separated from the cranial fossa by the dura mater, which forms the diaphragm of the sella turcica. The dura, as it forms the diaphragm, sends a layer downward to line the sella. The middle of the diaphragm is perforated by the infundibulum. Lateralward the dura passes over the sinus cavernosus to form its upper and lateral walls.

The relation of the arachnoid to the dura at the stalk of the hypophysis is of considerable interest from an operative viewpoint. Usually the arachnoid—surrounding the infundibulum as a sheath—extends downward only to the cranial side of the dura covering the sella, occasionally it stops even above this. It is only very rarely that the arachnoid passes below the diaphragm of the sella to spread over the surface of the hypophysis. If, in removing tumors, the operative procedures are below the diaphragm, there is but rarely any danger of opening the subarachnoid space, which, of course, would favor the development of meningitis.

The average weight of the hypophysis is 0.6 gm. (Schönemann, Boyce, and Beadles). It measures in longitudinal diameter 6 to 10.5 mm.; in frontal, 10 to 14.5 mm.; in vertical, 5 to 9.75 mm. (Zander).

The blood-supply of the anterior lobe is derived from the internal carotid and consists of fine branches which are given off from the artery while it is in the cavernous sinus. The arteries of the posterior lobe pass down with the pia mater which surrounds the infundibulum. The veins empty into two small vessels which communicate with the circular sinus.

The lobes—anterior and posterior—can be separated by inserting a scissors' point anteriorly at a depression which indicates the position of the cleft, the remains of the cavity of the original hypophyseal vesicle, and by following the line of cleavage. The posterior lobe is covered by epithelium which is of great physiologic importance. The two lobes contain three different parts—pars anterior, pars intermedia (Mark-

schicht, Epithelsaum), and pars nervosa. The anterior lobe is grayish-red externally, while the more central part is gray in color. Upon section the posterior lobe is grayish-green in color, this being due to the pigment-cells, which will be mentioned under the histology of the gland.

Histology.—In discussing the histology of the hypophysis the pars anterior, pars intermedia, and pars nervosa will be considered separately in the order given. We have found Zenker's and Bensley's fluids, the latter consisting of equal parts of a saturated alcoholic bichlorid and a 3 per cent. bichromate solution, the best fixatives. The stains which bring out the granules to the best advantage are iron-hematoxylin counterstained with eosin, neutral gentian, Mallory's connective-tissue, and Bensley's modified mitochondria stain.[1] Good fixations and stains which differentiate granules are absolutely necessary to the study of tumors of the hypophysis, for, as will be mentioned later, much of the confusion concerning the

FIG. 109.—FRONTAL SECTION OF HUMAN HYPOPHYSIS. (Lewis.)

a, Large anterior lobe; *b*, colloid cysts of pars intermedia; *c*, groups of basophilic cells distributed in nervous tissue of posterior lobe. These are regarded by many as invasions from anterior lobe. Findings are given in the text which would seem to indicate that they belong to the pars intermedia; *d*, pars nervosa near infundibulum.

etiologic relationship between tumors of the hypophysis and acromegaly has been due to a misinterpretation of the character of the tumor so commonly associated with the disease.

Anterior Lobe.—The anterior lobe is composed of branching and interlacing columns and rows of cells. Flesch and Dostojewsky described almost simultaneously, but independently of each other, two kinds of cells in the anterior lobe. These they called, according to their reactions to stains, chromophile and chromophobe cells. The chromophile cells, measuring 15 to 25 μ in diameter, are coarsely granular. They stain readily with iron-hematoxylin, fuchsin, eosin, and indigo-carmin. In fresh unstained preparations the chromophile appear darker than the chromophobe cells, which are also known as the chief cells. Schönemann divided the chromophile cells into the cyanophile or basophile and the eosinophile types depending upon their reaction to hematoxylin and eosin. In addition to these two principal types of cells, Rogowitsch described groups of nuclei surrounded by a scanty protoplasm which he regarded as embryonal or undifferentiated forms. Scaffidi believes that these represent the end-phases of secretion or exhausted cells.

[1] Bensley: "Studies on the Pancreas of the Guinea-pig," Amer. Jour. of Anat., No. 12, pp. 297–338.

Saint Rémy in 1892, from results obtained by the use of the Altmann granule technic, suggested that these types of cells were merely functional stages of each other. His conclusions have been supported by Claus and van der Stricht and Benda. Benda, using special fixing and staining methods, has been able to follow satisfactorily the transitional stages from the empty chromophobe to the loaded eosinophile cell. He describes the following types of cells: A small cell with irregular, clear, protoplasmic body containing fine granules, a larger round cell, the body of which is so filled with granules that only a small zone about the nucleus and a lighter area containing the centrosome remain free; and, finally, a large irregular cell containing isolated masses of stainable granules. In this last variety vacuoles are found which have been regarded by many as secretion vacuoles. These vacuoles are probably due to the dissolving out of fat during fixation and embedding, for the anterior lobe cell contains considerable amounts of it. These vacuoles give no clue to the secretory activity of the cells.

Lewis some time ago attempted to determine the relationship of these different types by exhausting the gland of rabbits with pilocarpine. This method, which has yielded such brilliant results in the study of the secretory phases of the cells of glands having an external secretion, failed to throw any light whatever upon the relation of the cells of the hypophysis.

Scaffidi, Erdheim, and others believe that the different types of cells are separate and distinct. Their contention is supported: (1) By the peculiar distribution of the different types of cells, (2) by the hyperplasia of a definite type of cell during pregnancy, which is so characteristic that a diagnosis of pregnancy can be made by a histologic examination of the hypophysis alone, and (3) by the occurrence of pure chromophobe adenomata, in which no traces of the chromophile cells are found.

At the present time it is impossible to state which view is correct. Pathologic evidence would seem to indicate that an unusually large number of cells heavily loaded with granules indicates that the anterior lobe is more active than normal, for by far the greater number of the hyperplasias or adenomata associated with acromegaly are composed of the chromophile cells. It must be admitted, however, that a chromophobe adenoma may be associated with acromegaly, such cases having been reported by Cagnetto and Modena. Such an association is, however, rare, and, besides, the effect of such an adenoma on the adjacent glandular tissue cannot be determined. We may have here a condition analogous to that existing between lesions of the thyroid gland and exophthalmic goiter. While usually a definite anatomic picture is found in the thyroid in cases of exophthalmic goiter, we know that symptoms of hyperthyroidism may supervene upon a fetal adenoma or cyst of the thyroid gland, the typical histologic features of exophthalmic goiter being absent.

The relative proportion of the chromophobe and chromophile elements varies with age. Isolated chromophile cells are found in the fetus. During postfetal life they gradually increase, until at thirty years they exceed in size and number the chromophobe elements. In old age they become small and lose their granules, but

can still be distinguished from the chromophobe cells. The basophile cells predominate in the anterior peripheral part of the gland, while the eosinophile cells are more numerous in that part of the gland bordering upon the posterior lobe.

Pars Intermedia (*Markschicht, Epithelsaum*).—It has already been noted that the juxtaneural portion of the hypophyseal vesicle early becomes differentiated from the anterior peripheral portion to form the pars intermedia. The pars intermedia is of considerable importance, for it is probable that it secretes all the physiologic active substances of the posterior lobe.

The histology of the boundary zone between the anterior and posterior lobes differs markedly from that of the anterior lobe. In the human hypophysis there are found in this boundary zone small clefts and acini filled with colloid. The lining membrane of the clefts consists of cylindric cells many of which are ciliated, while the acini are lined by low cubical epithelium. Histologically, this part of the gland resembles rather closely the thyroid gland. The clefts and the cavities of the acini are remains of the original cavity of the hypophyseal vesicle, which in man has been broken up into a number of smaller cavities, by infoldings of epithelium, and no longer persists as a distinct single cleft as in the ox and pig.

In the pig and ox, as is shown in Fig. 108, the pars intermedia is an epithelial layer of some thickness which covers the anterior portion of the pars nervosa, and becomes continuous at the margins of the cleft with the cells of the anterior lobe. The hypophysis of these two animals is the best for experimental purposes, such as studying the effects of extracts, for the pars intermedia can be isolated in a relatively pure state, and the effects of pure pars intermedia and pure pars nervosa studied separately. In both of these animals the pars intermedia is composed of cell columns and acini, some of which contain "colloid," consisting of clear cells, in which by the histologic methods now at hand, no granules or other types of secretion can be made out. The cells lining the acini have very distinct cement lines.

In the human hypophysis, besides the cells already described, there are found irregularly distributed throughout the pars nervosa groups and masses of basophilic cells which are regarded by Erdheim, Löwenstein, and others as invasions from the anterior lobe. Tilney describes the posterior wall of the hypophyseal cleft as being composed of a thick layer of medium-sized, faintly staining basophilic cells, many layers deep, which extend for a greater or less distance into the nervous tissue of the posterior lobe. A thick strand of these cells can be traced along the under surface of the processes infundibuli, even as far back as its dorsal extremity, at which point several well-defined collections of large-sized basophilic cells have been observed. A similar but narrower strand may sometimes make its way into and directly through the posterior lobe. We believe that these cells are derivatives of the pars intermedia, for they seem to develop from the epithelium bounding the hypophyseal cleft posteriorly. This epithelium, as we have already noted in discussing the embryology of the gland, becomes differentiated to form the pars intermedia, the epithelial investment of the posterior lobe.

The hypophysis of the cat may be cited to show that cells from the pars intermedia invade the pars nervosa. Herring states that the epithelial covering is in contact with the nervous portion and grows around it. The relation between the two is even still more intimate, for the cells of the epithelial covering invade the nervous portion. This ingrowth may take place at any part of the lobe, but in the cat's pituitary is most marked in the region of the neck of the infundibulum at the posterior reflection of the epithelium. In this position the epithelial cells frequently ac-

company the blood-vessels some distance into the lobe. Strands of cells which retain their connection with the epithelial investment are often seen passing some distance into the nervous lobe; at other times groups of cells of a similar nature are found in the nervous lobe at varying distances from the epithelial investment. These cells react to stains in the same way as do those of the epithelial investment.

In the adult cat these groups of cells are often very numerous, especially in the neck of the infundibulum, but they may occur at any part and are not infrequent in the middle of the posterior lobe, lying partly in the cavity. These groups vary in size from a few cells to twenty or more, and are usually compact. In the neck of the infundibulum they may have a looser structure, individual cells frequently being found between the fibers of the nervous portion. These are probably the cells considered by Berkley to be nerve-cells, but they are derived from the epithelial investment.

One of the most remarkable features of the pars intermedia, according to Herring, is the property that it possesses from a very early stage of development of spreading over and around the structures with which it comes in contact. It also tends to invade them and may spread some distance into the base of the brain in some animals. Occasionally, in some animals the nervous lobe of the hypophysis is almost transformed into an epithelial structure by this ingrowth from the epithelial investment. We have seen a very marked epithelial infiltration in a human hypophysis. Such an extensive ingrowth as just mentioned must, however, be exceedingly rare in the human hypophysis.

We shall see later that extracts of the posterior lobe of the hypophysis are very active physiologically. Histologically, the epithelial investment and the cells which invade the pars nervosa are the only elements of the posterior lobe which give any evidence whatever of secretion, and we believe that the active physiologic properties of the posterior lobe are dependent upon secretion from these cells.

Pars Nervosa.—The pars nervosa is composed of a framework of neuroglia and ependymal cells and fibers. Interspersed throughout are heavy connective-tissue fibers. There are no nerve-cells, and the cells regarded as such by Berkley were probably invasions from the epithelial investment such as have just been described. One of the most striking features of the pars nervosa is the amount of pigment which is found in some instances. In many cases it is heaped up and contained in the meshes of the connective tissue, as in old hemorrhages. The glia cells and fibers contain most of the pigment, the collections of which may be spindle-, pear-, or bullet-shaped. Besides these common forms there are bizarre ones. Only in rare instances is the pigment present in large amounts, frequently it is limited to small areas. The pigment, which can be made out with the naked eye, gives to the neurohypophysis the grayish-green color noted on cross-section.

In fresh specimens the pigment stains well with neutral red. It is best demonstrated in fixed preparations by iron-hematoxylin. When iron-hematoxylin is used the sections must be decolorized thoroughly so that the pigment masses can be differentiated from glia fibers. The pigment is highly resistant, for it is unchanged by the different fixing fluids, and is not dissolved during the process of embedding in either celloidin or paraffin. It is not soluble in boiling alcohol, and is not changed after standing for long periods in absolute alcohol, chloroform, or ether. It is not stainable with sudan III or Scharlachrot. If fresh specimens are allowed to stand for twenty-four hours in a 1 per cent. solution of osmic acid, the pigment is not blackened like a lipochrome substance, but assumes a darker brown or greenish-black color.

It is impossible to state what the origin and significance of this pigment is. It is neither a fat nor a lipochrome substance. It apparently increases with age and

is believed by Stumpf to be directly proportionate in amount to the number of epithelial cells which have invaded the pars nervosa.

Pathologically but little attention has ever been paid to these pigmented cells. Fischer, in studying the hypophysis from a patient eighteen years of age presenting Fröhlich's syndrome, noted marked changes in the posterior lobe, which was edematous, poor in cells, and mottled by numerous masses of pigment. The pigment was finely granular and had in Van Gieson preparations a yellow color. The pigment, partly in cells and partly free, was in small clumps, which corresponded in size to that of connective-tissue cells. Fischer regarded the changes in the posterior lobe as pathologic.

In discussing this case he states that it is well known that pigment occurs in adults, but that he had never seen in the hypophysis from so young a patient such amounts of it. He believed that in this instance the pigment indicated a brown atrophy of the posterior lobe, and that it was, therefore, suggestive of lessened activity.

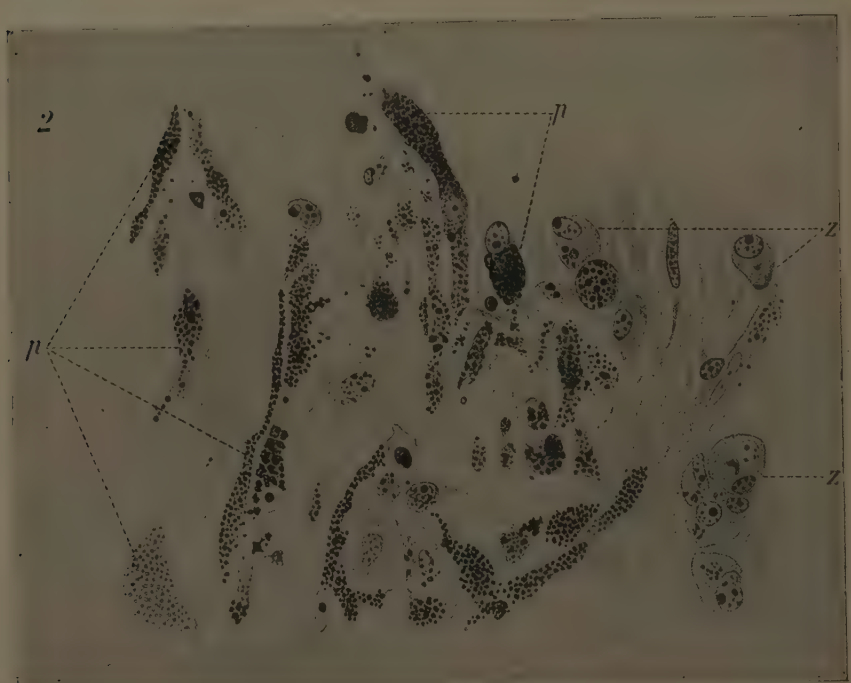

FIG. 110.—HISTOLOGIC PREPARATION OF THE PARS NERVOSA. (Kohn.)
p, Different varieties of pigmented cells in pars nervosa; *z*, basophilic cells in nervous tissue, mentioned under heading *c*, Fig. 109.

One of us (Lewis) has examined several hypophyses for pigment. The amount is so variable in subjects of the same age that it seems that it is impossible to form any opinion as to the physiologic activity of the posterior lobe by the amount of pigment contained therein.

Inclusions of Buccal Epithelium.—*Craniopharyngeal Duct Inclusions.*—Islands of squamous epithelium which are of more pathologic than histologic interest have recently been described in the hypophysis by Erdheim. This flat epithelium with distinct intercellular bridges, which can easily be demonstrated with iron-hematoxylon, occurs in the form of islands or strands which may be followed through several sections when

the gland is cut serially. Fig. 111 is a photomicrograph of a nest of this type of epithelium which was accidentally found in the hypophysis of a woman thirty years of age, who had died of peritonitis following an operation for ectopic pregnancy. In the upper right-hand part of the figure is a diagrammatic sketch showing the position of this epithelium which occurs among the acini of the pars intermedia. The intercellular bridges of the cells forming this nest can be plainly seen.

Erdheim, to determine the frequency with which these inclusions of flat epithelium occur, studied serial sections of twenty glands. As this type of epithelium cannot be accurately determined in the fetus and newborn, but thirteen series of sections were used in his studies. In ten

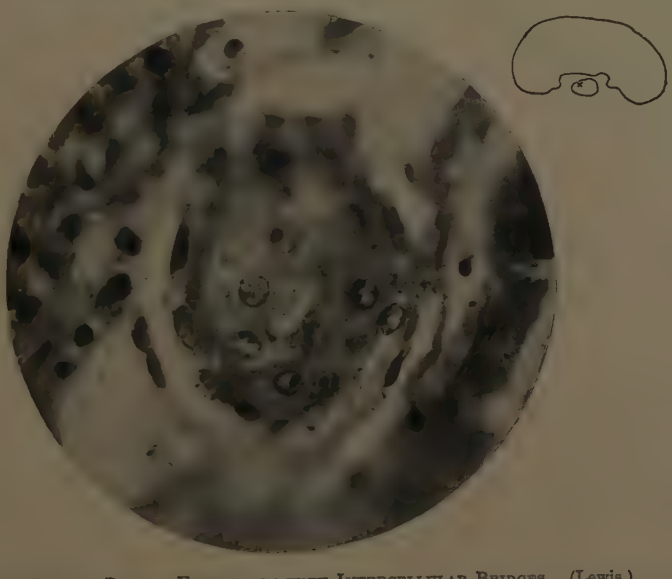

FIG. 111.—NEST OF BUCCAL EPITHELIUM WITH INTERCELLULAR BRIDGES. (Lewis.)

Found during the routine examination of a hypophysis removed from a woman thirty years of age who had died of peritonitis following an operation for ectopic pregnancy. The *x* in diagrammatic figure in upper right hand corner shows position of this cell-nest in the infundibulum. These cell-nests form the matrix for the most common tumor of the infundibulum and infundibular region.

of the thirteen glands he found islands of flat epithelium. These were situated in the infundibulum, about in the position indicated by the cross in Fig. 111, and in the upper surface of the anterior lobe immediately adjacent to it. This type of epithelium is rarely encountered outside of the two positions just mentioned.

The importance of this type of epithelium will be discussed later, when it will be seen that these islands of mouth epithelium form the matrix for the most common tumor of the infundibulum and the region immediately adjacent to it. The demonstration of the frequent occurrence of this type of epithelium in the hypophysis and its relation to tumor formation has simplified greatly the classification of tumors occurring about the infundibular region.

Nature of the Hypophyseal Secretion and Paths by which it is Discharged.—Attempts have been made by a number of investigators to determine the paths by which the secretion products of the hypophyseal cells are discharged and in what ways they gain access to the general circulation.

In discussing this subject the anterior and posterior lobes must be considered separately.

Haller believed that he had demonstrated a direct communication between the cell columns and acini of the anterior lobe and the subdural space. As the secretion accumulated, the cells would be separated or the acini widen, and when the secretion was discharged they would collapse again. Haller's findings have never been confirmed. Thom believes that the granular secretion of the chromophile cells and the thin secretion of the chromophobe cells become mixed, and that the secretion thus formed is forced through the alveolar membrane to be discharged into the interfollicular lymph-spaces. He reports the finding of colloid in the capillaries, but this has not been confirmed by Tilney and others. Histologic evidence would seem to indicate that the secretion products of the anterior lobe are discharged into the interfollicular lymphatics. The rich blood-supply of a sinusoidal character may permit of a direct absorption by venous channels.

The theory advanced by Herring as to the way in which the secretion products of the *posterior* lobe are discharged has attracted considerable attention recently. As we shall see later, Cushing and his coworkers have applied it in explaining many phenomena associated with intracranial lesions in which the hypophysis is not primarily affected. Herring states that in well fixed preparations, especially after fixation in Flemming's solution, there are found in the posterior lobe small hyaline bodies. These are highly refractive when unstained. These hyaline bodies, which stain indifferently with eosin and methylene-blue, lie scattered throughout the nervous substance of the posterior lobe. They are not so readily seen in formalin-fixed preparations, but can still be distinguished.

The appearance of these hyaline masses suggests that they are derived from cells which have undergone hyaline degeneration. No nucleus is found, the masses are structureless, and their outline is irregular. Occasionally, these masses may have a distinctly granular character, the granules being not unlike those of the cells of the anterior lobe, but not staining so deeply.

According to Herring, these masses seem to be of the nature of a secretion, not unlike diluted colloid material. In some situations the substance lies in what appear to be lymph-spaces lined with endothelium. The question naturally arises as to whether this material represents the physiologically active secretion of the posterior lobe. The substance often lies between the ependymal cells near the central cavity, and may possibly be a secretory product of these cells, in which case the nervous part might be regarded as a glandular structure. These hyaline masses are not, however, always confined to the nervous part, occurring occasionally among the cells of the epithelial investment, especially where it is thickened just below the neck of the infundibulum, which would seem to indicate that these masses are derived from those cells covering the nervous portion of the posterior lobe. The masses are most abundant in the neck, and around the central cavity and in the neighborhood of the strands of epithelial cells which invade the pars nervosa.

Herring believes that these hyaline masses are discharged by way of the infundibular canal into the cerebrospinal fluid, with which the secretion of the posterior lobe eventually reaches the dural sinuses. Cushing and his coworkers have obtained a pressor effect from cerebrospinal fluid, which they believe is due to posterior lobe secretion which has gained access to it in the way just mentioned.

Edinger has attempted to determine the paths of secretion by the injection method. He does not differentiate between anterior and posterior lobe secretion. His conclusions are that the hypophyseal secretion is discharged into the brain, thus accounting for the intimate relation between the hypophysis and brain which is found in all vertebrates. He believes that his work is confirmed by the results of some physiologists, especially Paulesco, who maintains that stalk ligation is the equivalent of total hypophysectomy. There are certain inconsistencies in this conclusion, for Paulesco has maintained that total removal of the posterior lobe has no effect upon the animal. In this operation the paths of secretion would be even more completely blocked than after stalk ligation.

There are certain objections to Herring's theory: (1) No antecedent secretion is found in the cells of the pars intermedia. (2) The total aggregate of the hyaline masses is considerably greater than the number of cells undergoing hyaline degeneration. Lewis has found hyaline masses along the posterior border of the infundibulum where there is no epithelial investment.

While hyaline bodies have been demonstrated apparently wandering through the pars nervosa and the stalk to the third ventricle, we have no conclusive evidence that they represent the pressor substance, for the latter can be extracted from pure pars intermedia, pieces of which remain attached to the anterior lobe during separation of the two lobes, in which these hyaline bodies are not found.

The opinions of different investigators concerning the nature of the " colloid " vary. Benda and Gemelli believe it a degeneration product, while others regard it as the secretion product of the pars intermedia. The presence of ciliated epithelium in some of the acini would suggest that it might be a degeneration product, for pharyngeal and esophageal epithelium, when undergoing regressive changes ending in cyst formation, often become ciliated.

Physiology.—Attempts have been made to determine the functions of the gland by studying the effects of complete and partial removal, of subcutaneous and intravenous injections of extracts of its various anatomic components, and by feeding experiments.

Effects of Complete Removal.—The results following the early attempts at total removal of the gland were not uniform, and there has consequently arisen considerable discussion as to whether or not the gland is essential to life and as to what symptoms follow its removal. Horsley in 1886 extirpated the gland and reported that no physical or mental changes developed in the animals surviving the operation. Gley, after removal of the thyroid gland and spleen, extirpated the hypophysis, and found that the symptoms following this extensive operation did not differ from those following removal of the thyroid alone, while Vassale and Sacchi noted that a high percentage of the animals died after the operation, but few surviving long enough to permit of extensive studies.

The early work has been repeated by a number of different investigators. Marinesco, Gatta, Casselli, Perrone, and others believe that the organ is essential to life and that animals survive its removal by but a few hours. Friedman and Maas, Lo Monaco and van Rynberg, Fichera and Gemelli believe that the gland can be removed without causing the death of the animal, and that when animals do die after removal it is from some operative accident, such as hemorrhage or infection.

The lack of uniformity in these results can be accounted for by the difficulties of the operation with the attendant infection and by the uncertainty of complete removal because of the poor operative approach used by the earlier operators. Even a small fragment of the anterior lobe if left, will rapidly undergo hyperplasia and may secrete enough greatly to modify the final results. The perfection of a method which permits of removal of the hypophysis under direct inspection, thus permitting of avoidance of injury to the brain and the control of hemorrhage, has been followed by more uniform results.

The method devised by Paulesco permits of removal of the entire hypophysis or parts of the same under direct inspection. When speaking of total removal it should be borne in mind that fragments of the pars intermedia which passes well up onto the stalk may be left even after a most complete operation. The experimental work of Cushing and his co-workers, who have confirmed and added to Paulesco's work, has added greatly to our knowledge of the physiology of the gland and has explained many of the clinical phenomena associated with hypophyseal disease.

According to Paulesco and Cushing, total removal is not compatible with life. Paulesco found that animals frequently died within twenty-four hours after total re-

moval, while Cushing found that adult dogs lived somewhat longer, two to three days, and that young dogs survived the operation on an average of eleven days. The animals surviving the operation developed a rather characteristic train of symptoms, consisting of apathy; subnormal temperature; rapid and irregular pulse; coarse muscular twitching after slight external stimuli; a peculiar arching of the back when standing or walking, the hind feet being placed forward, and a stiff, unsteady gait, walking becoming more and more difficult. These symptoms, which Cushing has grouped under the term cachexia hypophyseopriva, gradually increase in severity until the animal passes into coma and dies.

Paulesco found that even small fragments of the anterior lobe were enough to keep the animal alive. He did not notice any effect after partial removal of the anterior lobe. Cushing and his co-workers noted in their first series of experiments that after partial removal of the anterior lobe some fairly characteristic symptoms developed after a time. The animals became fat and lost the secondary sex characteristics. In young animals, glycosuria and skin changes, such as edema and hypotrichiasis, were noted.

Complete anterior lobe removal is the equivalent of complete hypophysectomy.

Results of Posterior Lobe Removal and Stalk Ligation.—The results of posterior lobe removal and of ligating the stalk or placing a clip upon it vary with different investigators. Paulesco stated that removal of the posterior lobe has no effects other than those which might be expected from an operative procedure of this magnitude. Stalk ligation, on the other hand, had been with him the equivalent of total hypophysectomy. There are certain inconsistencies about these results, for it is difficult to see how stalk ligation would be fatal, while posterior lobe removal has no effect. In the latter operation the paths of secretion would be as much interfered with as in stalk ligation and, besides, the operation offers more technical difficulties.

Goettsch, Cushing, and Jacobsen state in a recent article that when the operation upon the posterior lobe has caused a subsequent and permanent insufficiency of its secretion, either by removing a considerable portion of the lobe with its epithelial investment or by interfering with the discharge of its secretion by placing a clip upon or ligating the stalk, that a temporary lowering of the assimilation limit for carbohydrates, such as occurs after manipulation of the stalk when not permanently damaged, is noted. This temporary lowering is followed by an increased tolerance for sugars, which persists.

Certain physical changes are apt to accompany this increased tolerance for carbohydrates. There is a tendency for the animal to acquire a generalized adiposity, which probably is due to the conversion of stored sugars into fat. During the tests to establish carbohydrate tolerance, whether in experimental or clinical cases of posterior lobe deficiency, Cushing states that there often occurs a notable accretion in body weight. The patients are apt to have a subnormal body temperature, suggesting an imperfect oxidizing or metabolizing capacity, and the persistently lowered temperature can be raised by the injection of glandular extracts. Repeated hypodermic injections of the posterior lobe extract in normal animals may cause a profound degree of emaciation, presumably from lessened carbohydrate tolerance developing during the administration of the extract.

For the reasons just given, Cushing believes that the tendency toward adiposity displayed by partially hypophysectomized animals is not due solely to lessened anterior lobe secretion, an opinion advanced in a paper by Crowe, Cushing, and Homans.

It will be seen that opinions as to the physiology of the posterior lobe differ. Fischer, as the result of pathologic studies, stated some time ago that Fröhlich's syndrome was due to alterations in posterior lobe secretion, and Lewis in 1910 stated that this syndrome was probably due to destruction of the pars intermedia, for the tumors most frequently associated with it are destructive in character and so situated that they would interfere with the viability and function of the cells of the pars intermedia.

It should be remembered in interpreting these results that it is practically impossible to remove all of the pars intermedia in posterior lobe removal, for fragments of it may remain attached to the stalk and to the anterior lobe at the margins of the cleft.

The results of complete and partial removal of the gland may be summarized as follows: (1) Complete hypophysectomy is fatal, death occurring in from two to five days in adult animals, in eleven days in

younger ones, a definite train of symptoms which may be grouped under the term cachexia hypophyseopriva developing; (2) total anterior lobe removal is the equivalent of total hypophysectomy; (3) removal of the posterior lobe, stalk ligation, or placement of a clip upon the stalk are followed by certain changes related to carbohydrate metabolism and certain physical changes which resemble those described in man under the term of Fröhlich's syndrome.

Effects of Intravenous Injections of Hypophyseal Extracts.—*General Effects.*—After intravenous injections of either anterior or posterior lobe extracts animals exhibit a peculiar train of symptoms. Shortly after the injection the animal can no longer coördinate his movements, the hind legs being especially affected. He yawns, pants, and becomes apathetic, often lying down, and moves only after much coaxing. The mucous membranes become very pale. The animal exhibits these same preliminary symptoms when posterior lobe extracts are injected, but soon begins to cry out and whine as if in pain, becomes salivated, and vomits and purges, blood and mucus often being passed. If the hand is placed upon the abdomen, violent peristaltic movements may be felt. Polyuria is often noted after the injection of posterior lobe extracts. The effects of anterior lobe injections, which do not cause the vomiting, purging, and polyuria, are rapidly recovered from, while those following the injection of posterior lobe extracts may last five or six hours.

Enormous doses of posterior lobe extracts do not prove fatal, the animals recovering in almost all cases. Smaller amounts of adrenalin, relative to body weight, prove fatal to animals, which after toxic doses of this substance apparently die of edema of the lungs.

Effects of Extracts Upon Blood-pressure—Part of Gland Secreting Pressor Substance.—Oliver and Schäfer were the first to demonstrate that intravenous injections of hypophyseal extracts caused a rise in blood-pressure. Howell later demonstrated that the pressor substance was confined to the posterior lobe and that the rise in blood-pressure was associated with marked slowing of the pulse. Lewis, Miller, and Mathews have recently demonstrated that the pressor substance is a secretion of the pars intermedia. It can be extracted from any part of the gland containing pars intermedia, in its purest form from a fringe of pars intermedia which frequently remains attached to the anterior lobe during the process of separating the two lobes. The pressor substance passes back into the pars nervosa after secretion by the pars intermedia, for extracts of the pars nervosa, after all the epithelial elements of the pars intermedia have been cut away, give a pressor effect.

All portions of the hypophysis contain a depressor substance soluble in alcohol, which is probably the same as the depressor substance found normally in all tissues.

Fig. 112 is the reproduction of a blood tracing obtained from the carotid artery of a dog which had been injected intravenously with a posterior lobe extract, the depressor substance having been previously removed. After the injection there is a prompt rise, which is soon followed by a fall. The fall is succeeded by a rise, the secondary rise being associated with marked slowing of the pulse. While the rise is not as high as after adrenalin injections, it lasts much longer. The cardiac slowing associated with the secondary rise was first noted by Howell. The figure in the text is very similar to one given by Garnier and Thaon. The slowing of the pulse is not constant, but when present it is not abolished by section of the vagi or by atropin. Therefore, it must be of peripheral origin and not due to the same cause as the inhibition which often accompanies the action of adrenalin, which is brought about by action upon the cardio-inhibitory mechanism of the bulb.

Extracts of the posterior lobe contract isolated segments of the carotid, mesenteric, and femoral arteries. They also contract the coronary arteries, thus differing from adrenalin, which dilates them. Some of the peculiar symptoms after injection

of posterior lobe extracts, such as the crying out and evident distress, may be due to coronary artery contraction.

The renal arteries, as shown by Schäfer and Pal, are dilated by posterior lobe extracts. Schäfer believes that the entire renal artery is dilated, while Pal states that only the peripheral branches, those immediately adjacent to the renal pelvis, are affected. According to Pal, pilocarpin has much the same effect on vessels as posterior lobe extracts. Pilocarpin contracts the mesenteric, femoral, coronary, and carotid arteries, but dilates the entire renal, this action not being limited to the peripheral branches, as is the case with hypophyseal extracts.

Polyuria.—Polyuria after intravenous injection of posterior lobe extracts was first noted by Schäfer and Magnus in 1901. Schäfer and Herring in 1906 continued this early work, and found that these extracts have a specific action upon the renal vessels and probably upon the kidney cells. As just mentioned, while these extracts contract most of the arteries of the body, they have an opposite effect upon those supplying the kidney, differing from adrenalin, which contracts the renal, but dilates the coronary, arteries. The dilation, which is marked and lasting, may be preceded by a temporary contraction. An increased flow of urine does not always accompany the injection of posterior lobe extracts, and while it is undoubtedly favored

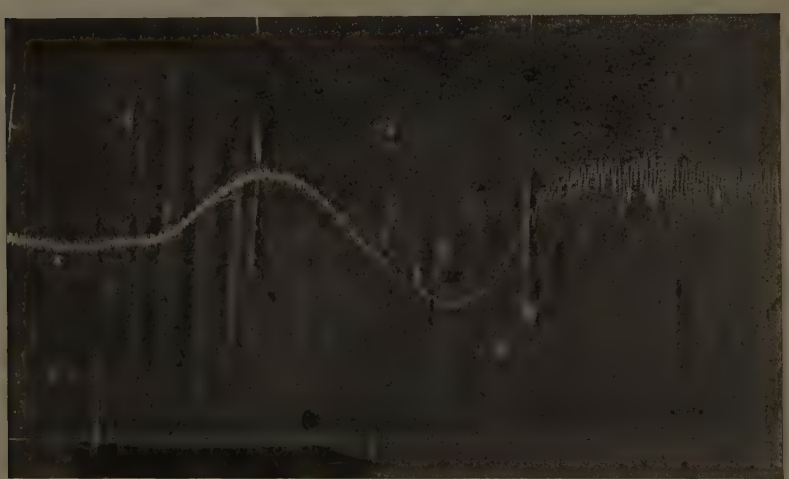

FIG. 112.—BLOOD-PRESSURE TRACING FOLLOWING INTRAVENOUS INJECTION OF POSTERIOR LOBE EXTRACTS. (Lewis, Miller, Mathews.)

This curve shows a prompt primary rise followed by a fall, which is succeeded by a rise, accompanied by marked slowing of the pulse.

by dilatation of the renal arteries, which is coincident with the rise in general blood-pressure caused by contraction of the arteries, it is not entirely the result of these changes. Schäfer believes that the substance causing the diuresis is independent of that causing the pressor effect, for diuresis occurs after repeated injections of the extract, the second and following injections of which almost invariably cause a fall in pressure. He also noted that in a large proportion of experiments a common occurrence is temporary diminution or cessation of urinary flow, even though the blood-pressure is raised to a considerable extent, conditions which on the mechanical or filtration theory of urinary secretion invariably produce diuresis. Diuresis has also been noted by Schäfer in some instances after feeding posterior lobe extracts to children.

The presence of this diuretic substance accounts for the polyuria associated with hypophyseal disease. We shall later note, in discussing some of the clinical phenomena associated with Fröhlich's syndrome, that diabetes insipidus occurs in 7 per cent. of these cases. Overactivity of the pars intermedia is the most satisfactory etiology yet suggested for diabetes insipidus.

Posterior lobe extracts also increase the flow of milk. These extracts stimulate smooth muscle; the active peristalsis in dogs has already been mentioned. Frankl-Hochwart and Fröhlich have studied the effect of pituitrin (Parke-Davis prepara-

tion) upon smooth muscle. They have found that the extract stimulates the bladder musculature and increases its irritability to the faradic current, also that it stimulates the rabbit's uterus. Blair-Bell states from clinical experience that it causes contraction of the pregnant and menstruating uterus. At the present time numerous reports concerning its value in gynecologic and obstetric practice are appearing. Its use has been advised in postoperative urinary retention not due to obstruction.

The chemical nature of the active substance or substances of posterior lobe extracts is not known. Physiologically they react in many ways like adrenalin, causing, for example, dilatation of the pupil of the enucleated frog's eye. They do not, however, give the iron-chlorid reaction of adrenalin.

Relation of the Hypophysis to Other Glands of Internal Secretion.—A close relationship seems to exist between the hypophysis and other glands with an internal secretion, especially the thyroid, ovaries and testicle, and pancreas. In hypophyseal disease many changes are noted which appear to be secondary to alterations in one of the above-mentioned glands. In acromegaly the skin often presents myxedematous changes; in Fröhlich's syndrome the first change noted may be sexual infantilism, while glycosuria is of common occurrence in acromegaly.

The occurrence of colloid in both the hypophysis and thyroid is suggestive of an interrelation of function. This was especially emphasized when iodin was said by Schnitzler and Ewald to occur in the hypophysis in the same form as in the thyroid. This finding has lately been disproved by Halliburton, and as a consequence there is considerable doubt as to whether any vicarious relation exists between the two glands. Rogowitch was the first to study experimentally changes in the hypophysis after thyroidectomy. He believed that in animals which survived thyroidectomy the hypophysis assumed the function of the thyroid, and described certain changes in the hypophysis of animals from which the thyroid had been removed, such as an increase in the nuclear masses of the anterior lobe of the gland, and the formation of colloid in the chromophile cells, from which it passed directly into the blood-vessels or colloid vesicles of the "Markschicht"—the pars intermedia.

The occurrence of an enlarged hypophysis in myxedema and cretinism seemed to confirm Rogowitch's theory that a vicarious relation existed between the two glands. Hypophyses of patients living in goitrous districts may present some definite changes. Schönemann has studied the hypophyses of patients dying in districts where goiter is common. Among 172 examined, 85 presented definite histologic changes, while 27 were normal. The changes found in the 85 varied: an increase in the amount of connective tissue, colloid degeneration, and an increase of the chromophile cells were the most common. In view of the fact that iodin is not found in the hypophysis, the earlier work of Schnitzler and Ewald having been discredited, it is probable that the hypophysis cannot act vicariously for the thyroid gland, and that as close a relation does not exist between the glands as was formerly believed. The connective tissue varies so much in different hypophyses that it is difficult to establish the normal, and we know that vacuolization, which has been emphasized so much as being an index to the secretory activity of the cell, is due to the dissolving out of fat during the process of embedding.

In some statistics recently prepared by Creutzfeldt, dealing with a clinical study of 118 cases of acromegaly, hyperplasia or struma of the thyroid was found in 7 patients, or 5.9 per cent. of the cases; a percentage probably no higher than that existing in lesions of other ductless glands or in practically normal individuals.

Simpson and Hunter have recently published an article upon the vicarious relationship between the pituitary and thyroid glands. They summarized their findings as follows: (1) Complete removal of the thyroid gland in lambs from seven to eight months old and in adult sheep does not lead to the appearance of iodin in the pituitary even after so long an interval as from five to six months. On the assumption that the iodin-containing substance of the thyroid represents its active secretion, this does not support the Rogowitch theory that in thyroid insufficiency the pituitary vicariously takes on its function. (2) Compared with normal animals of the same age there is evidence of some increase in the size of the pituitary in the thyreodectomized lambs and sheep, but this not so great as has been reported by many observers in other experimental animals, notably the rabbit, nor in some cases of myxedema and cretinism in the human subject. In the case of lambs this increase amounted to about 15 per cent., and in the adult sheep to about 20 per cent., in from five to six months.

The hypophysis has been examined in but few cases of Graves' disease. Benda has examined the pituitary glands from 3 cases of Graves' disease, and Lewis from 1. In 2 of Benda's cases the hypophyses were small and indurated, and in 1

the gland was macroscopically normal. The alveoli in the former were small and contained few chromophile elements; the cells were atrophic, vacuolated, and contained dark brown pigment. In the gland examined by Lewis the stroma was heavy, the chromophile cells apparently normal in number, but were smaller and more vacuolated than usual. While these glands have been described as atrophic, we believe it impossible to say whether or not the changes were secondary to hyperactivity of the thyroid gland. It is interesting to note, however, in this connection that the delicately pointed fingers of patients suffering with Graves' disease, which have been compared by Revilliod to the fingers of the madonnas of Raphael and Perugino, are in marked contrast to the blunt fingers of the acromegalic.

Relations Between the Hypophysis and the Organs of Generation.—Amenorrhea or impotence may be one of the first symptoms of hypophyseal disease, often antedating by years the growth changes; while changes occur in the hypophysis during pregnancy which are so characteristic that a diagnosis of the condition can be based upon the histologic changes in the gland alone. These clinical phenomena and histologic changes indicate that the hypophysis and ovaries and testicles are closely related.

Comte, Launois, and Mulon were the first to demonstrate that the hypophysis enlarges during pregnancy. Marek has recently reported a case of what he calls acromegaly during pregnancy. During the first pregnancy of a patient aged twenty-six years, acromegalic symptoms accompanied by glycosuria developed. After delivery the symptoms subsided. He believed these symptoms due to hypophyseal hypertrophy occurring during pregnancy, which within certain limits is physiologic, but in the case observed by him bordered on the pathologic. Other clinical observations have been made in which after repeated pregnancies hypophyseal hyperplasia of such an extent has occurred that it has caused bitemporal hemianopsia. Reuss has reported a case in which the hyperplasia was marked enough to produce pressure upon the optic nerves interfering with vision. During the fifteenth and sixteenth pregnancies the vision became much less acute, but improved rapidly after delivery.

Erdheim and Stumme have shown that characteristic histologic changes occur during pregnancy. Associated with the enlargement of the hypophysis, there is a marked proliferation of the chief cells which become transformed into a granular cell of pregnancy, which is to be regarded as a third type of chromophile cell. It is well known that the mother during pregnancy becomes plumper, that the fingers, lips, and nose thicken, changes which in many respects are characteristic of beginning acromegaly.

Evidence is conclusive that the hypophysis enlarges after castration, as was first demonstrated by Fichera. He found the gland twice as heavy in capons and oxen as in the same species of about the same weight and size when not castrated. Although these findings were not confirmed by Schutz, there is enough confirmatory evidence by others that such changes after castration should not be doubted. Even enlargement of the sella turcica has been described in castrated subjects by Tandler and Grosz.

Castration has a very evident effect upon body growth. Eunuchs are usually large, the arms and legs being disproportionate to the length of the trunk. According to Bartel, castrated children grow rapidly as soon as puberty is reached. Girls who reach puberty late are on an average taller than those reaching puberty early, the appearance of sexual function stopping the hyperplasia of the hypophysis. Tandler and Grosz, in studying the influence of the interstitial cells of the testicle and ovary upon body form, have arrived at interesting conclusions regarding the relation between these and the hypophysis. They have shown that removal of the testicles or ovaries or a hypoplasia of the same leads to late ossification of the epiphyseal cartilages. Women reach the age of puberty on an average earlier than men and are shorter of limb, as the ovarian is no longer correlated with hypophyseal function. The changes suggestive of acromegaly which occur during pregnancy are probably not due to pregnancy *per se* but the arrest of ovarian function occurring at this time.

People of northern climes, where puberty appears late, are, on an average, taller than those of warm climes, where puberty appears early.

Clinical evidence would seem to indicate that a most intimate relationship exists between the hypophysis and the sexual organs, for we shall see later that amenorrhea and impotence may be the earliest indication of hypophyseal disease, antedating often by years the neighborhood symptoms caused by the developing tumor.

Relation Between the Hypophysis and Pancreas.—The frequent occurrence of glycosuria in acromegaly would indicate a close relationship between the hypo-

physis and pancreas. The frequency with which glycosuria occurs varies with different authors. Hansemann in 1897 collected reports of 97 cases of acromegaly; 17 of these had glycosuria. Creutzfeldt in 1908 tabulated statistics of 118 cases of acromegaly and found that glycosuria had been observed in 13 cases, or 11 per cent. According to the different statistics, glycosuria occurs in from 11 to 40 per cent. of the cases of acromegaly.

Reports of the effects on carbohydrate metabolism of injecting and feeding the active principles of the hypophysis have been conflicting. Borchardt injected into rabbits extracts prepared from the entire hypophysis, and obtained in 80 per cent. of the animals a more or less marked glycosuria. The sugar appeared three or four hours after the injection, and rarely lasted for more than twenty hours. The extreme susceptibility of the rabbit to disturbances of sugar metabolism modifies the significance of these experiments. Spontaneous glycosuria is common in rabbits and slight disturbance or manipulation may excite it. Borchardt later repeated the experiments on dogs. Five of the seven animals reacted with a glycosuria, but none of the experiments were conclusive, as two of the animals presented glycosuria only when on a carbohydrate diet, and two had previously had a portion of the pancreas removed, the animals, however, being sugar free. Finally, the other positive case had, following the injection, a severe, prolonged tremor, such as is common after intravenous injections of hypophyseal extracts. Pal and Franchini have reported negative results.

As extracts of the posterior lobe of the hypophysis and adrenalin have so many things in common, one would be justified in believing that extracts of the posterior lobe might, like adrenalin, have an inhibiting influence upon the pancreas and cause glycosuria. Lewis and Miller tried to determine the effect upon carbohydrate metabolism of extracts of the anterior and posterior lobes injected separately. Dogs were injected intraperitoneally and intravenously with freshly prepared extracts. In all, 30 animals were thus treated, 15 with extracts of the anterior lobe and 15 with extracts of the posterior lobe. In only 3 of the animals were they able to detect a glycosuria, although a reducing substance was frequently found in the urine. The amount of sugar present as determined by the polariscope and fermentation test did not exceed 0.5 per cent. Two of the positive cases received extracts of the anterior lobe, one an extract of the posterior lobe. If they are justified in assuming that extracts of the hypophysis may excite a glycosuria, it must be due to a substance common to each lobe; as the only structure common to both lobes is the pars intermedia, it may be suspected that this portion of the gland is responsible for the glycosuria.

Goetsch, Cushing, and Jacobsen, as the result of their experimental work, have come to the following conclusions: (1) That it is the posterior lobe secretion which is chiefly concerned in the deviations from the normal in the tolerance for carbohydrates; (2) that a persistent lowering of the assimilation limit can be brought about only by an overactivation of this part of the gland, a physiologic state which has not as yet been produced experimentally; (3) that glandular extirpations which include the posterior lobe lead to a terminal increase in sugar tolerance, rather than to the long-sought lowering of the assimilation limit. There is, according to Cushing and his co-workers, in acromegaly an activation of the posterior lobe leading among other symptoms to a glycosuria or lowered sugar tolerance. In later stages of this disease, through actual destruction or invasion or compression of the posterior lobe and pars intermedia, a state of posterior lobe insufficiency supervenes with increase of carbohydrate tolerance.

No data are found concerning the condition of the hypophysis after removal of the pancreas or of the pancreas after removal of the hypophysis, and but little mention is made of the condition of the pancreas, especially of the islands of Langerhans in patients dying of acromegaly.

Pathology.—Since Marie in 1889 called attention to the fact that a tumor of the hypophysis, supposed by him to be destructive in character, was frequently associated with acromegaly, the clinical aspects of which he had described three years before, there has been an active dispute, which still continues, concerning the rôle which lesions of the gland play in the etiology of the disease. In discussing the pathology of the hypophysis, tumors of the anterior lobe and of the infundibulum and infundibular region will receive most attention.

Character of the Tumor Associated with Acromegaly.—Much of the confusion which has existed concerning the relationship between tumors of the hypophysis and acromegaly has been due to a misinterpretation of the character of the tumor associated with the disease. The lack of uniformity in the anatomic diagnosis of lesions of the hypophysis in acromegaly may be illustrated by the statistics compiled by Furnivall in 1898. He found 49 cases of acromegaly in the literature at that time, and in all but 2 of the cases the hypophysis was larger than normal. In the 47 cases in which the hypophysis was enlarged the following diagnoses of the gland lesion were made: simple hypertrophy, adenoma, sarcoma, cystic tumor, hypertrophy and colloid degeneration, marked colloid degeneration and hemorrhage, glioma, cylindroma, etc.

The lack of uniformity in the classification of the pathologic change in the gland in the early cases was due to a failure to recognize that anterior lobe cells, when proliferating rapidly, assume the morphology of sarcoma cells, and that different clinical stages of the disease might be associated with different degrees of pathologic changes, which in their finality were consecutive, passing through hyperplasia to adenoma formation, and from the latter to cyst formation, the cyst being coincident with the cachectic or terminal stage of the disease.

Tamburini in 1894 described an adenoma of the hypophysis in a case of acromegaly, and stated that he believed that acromegaly was caused by a hypersecretion of the anterior lobe, and that the hyperplasia or adenoma associated with the disease might later undergo degenerative changes leading to cyst formation which might be associated with the cachexia.

Since Benda and Mendel have demonstrated that most of the tumors of the anterior lobe occurring in acromegaly were hyperplasias or adenomata and not sarcomata, a definite anatomic basis has been established for acromegaly. Creutzfeldt has recently tabulated the pathologic changes in the hypophysis in 56 cases of acromegaly as follows:

Number of cases.	Character of lesion.	Per cent.
5	Without hypophyseal enlargement or lesion not mentioned.	8.9
15	Sarcoma.	26.7
12	Hyperplasia.	21.4
8	Struma.	14.2
12	Adenoma.	21.4
4	No anatomic diagnosis.	7.1

It will be seen from this table that hyperplasia, struma, or adenoma of the hypophysis was found in 57 per cent. of the cases of acromegaly. It is more than probable that most of the cases regarded as sarcoma were actually hyperplasias or adenomata of the anterior lobe.

If those cases are excluded in which no anatomic diagnosis was made or changes noted, we find that there is a uniform pathologic change in the hypophysis in this series of acromegaly. The constancy of the hypophyseal change and the frequency with which the same lesion is repeated cannot be overlooked in determining the relationship between hyperpituitarism and acromegaly.

Cases of acromegaly have been reported in which adenomata of the hypophysis were found, which were composed entirely of chromophobe elements, regarded by many as the least actively functioning cells of the gland. Such cases have been reported by Cagnetto and Modena and have been advanced as arguments against hyperpituitarism as the essential etiologic factor in acromegaly. It is difficult to determine what effect such a growth would have upon the remaining cells of the gland. The similarity between hypophyseal and thyroid changes have been emphasized for some time. Hyperthyroidism may be associated with fetal adenomata and even chondromata of the thyroid gland, and although actively functionating thyroid cells are not found in the tumors, the symptoms subside when they are removed. The same relation may exist between an adenoma of the hypophysis, composed entirely of chromophobe elements, and acromegaly as may exist between fetal adenomata of the thyroid and hyperthyroidism.

Typical eosinophilic adenomata of the hypophysis without symptoms of acromegaly have been described by Kollaritis, Harbitz, Cagnetto, Zak, and Creutzfeldt. Adenomata composed entirely of chromophobe elements have been reported by Krumbhaar, Creutzfeldt, Carbone, and Dimel. Ribbert, Hippel, Parodi, and others have described adenomata which presented different histologic pictures in different areas, chromophobe and chromophile elements being distributed separately in different parts of the tumor. Strada describes such a case, classifying the tumor studied by him as a hypophyseal struma undergoing malignant degeneration.

Chromophobe adenomata are not usually associated with acromegaly. They are more commonly accompanied by adiposity and polyuria, features of Fröhlich's syndrome. Cushing, in his article upon dyspituitarism, discusses chromophobe adenomata under the second heading as cases in which the neighborhood manifestations are pronounced, but the constitutional symptoms are inconspicuous. In these cases there are found the regional signs of tumor, but the disturbances of hypophyseal activity are so slight that they might be overlooked on superficial examination. Close examination will often, however, disclose some trace of skeletal change, either on the side of, over, or under growth, and some evidence of deranged carbohydrate metabolism with a tendency to adiposity.

But few opportunities have been offered of studying the hypophyseal changes early in the clinical course of acromegaly, for usually the acromegalic dies of increasing intracranial pressure after a long clinical course, and as a result most of the descriptions given of the changes in the hypophysis have been made from fully developed or degenerating tumors.

In 1905 Lewis reported the findings in the hypophysis of a patient suffering from acromegaly, who died early in the clinical course of chronic acromegaly, death being due to cerebral embolism. The patient was forty-six years of age. For six years the patient had noted a gradual but constant enlargement of the head and feet. No measurements had been taken, but the patient stated that six years before he wore a $7\frac{1}{4}$ hat and

a No. 9 shoe, whereas at the time he entered the hospital he required a No. 8 hat and upward of an 11 shoe. He had not worn gloves, and could not, therefore, give any information concerning the increase in the size of his hands, but judged from appearances that they also had become enlarged. The typical facial changes of acromegaly were noted. The patient, when he died of cerebral embolism, was evidently in the early clinical stages of acromegaly.

The autopsy revealed a hypophysis which macroscopically appeared normal, but there were microscopic changes which corresponded in many ways to those of adenomata associated with acromegaly which have been described by Shattock, Brooks, Benda, Mitchell and Le Count, and others. These had to do with the character, number, and arrangement of

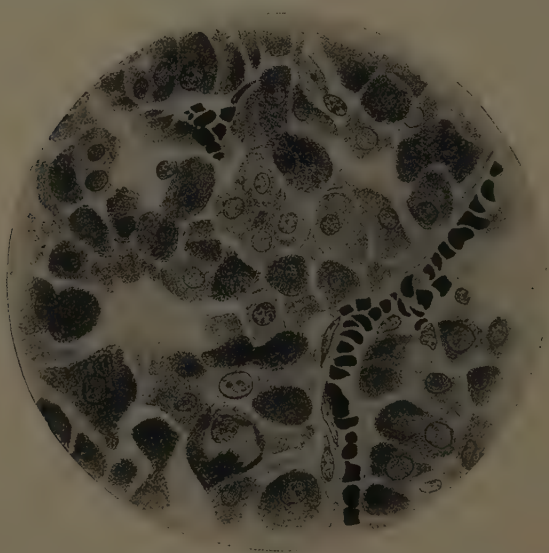

FIG. 113.—SECTION FROM THE HYPOPHYSIS. (Lewis.)

Removed from a patient who died early in the clinical course of acromegaly from cerebral embolism. The gland appeared to be normal macroscopically. Microscopic examination revealed a disappearance of the stroma and fusion of cell column, with very definite evidences of hyperplasia. Most of the cells are of the chromophile type.

the cellular elements. The stroma was reduced in amount. In the normal hypophysis there is a well-developed connective-tissue stroma, while in the hypophysis from this early case of acromegaly there was but very little stroma, the cells resting directly upon the endothelial walls of the capillaries, being irregularly grouped together in the intercapillary spaces. All the changes in the gland, the great excess of highly functioning chromophile cells, their irregular distribution, and the lessened amount of stroma, were indicative of overactivity of the anterior lobe.

Sections from this case were compared with those of tumors of the hypophysis taken from cases of acromegaly, and the histologic change, a hyperplasia or increase of the glandular cells of a peculiar type, corresponded closely to those of the case under discussion, in which there was no

gross enlargement. This case has been criticized by Stumme, who says that it is a well-known fact that chromophile cells predominate in the posterior part of the gland, and by Cagnetto, who believes that similar changes might be caused by infections. Serial sections were made to avoid the mistake suggested by Stumme, and we have examined sections of the hypophysis of a number of patients who have died of infections, and have never found changes comparable to those observed in this early case of acromegaly.

We believe that the changes noted in this case are peculiar and distinctive of the hypophysis in the early stages of acromegaly. It is probable that if the disease had pursued its usual clinical course, not having been interrupted by death due to cerebral embolism, that the gland would have become enlarged; perhaps, incidentally, the seat of the tumor-like hyperplasia of cells which are normally found in the hypophysis.

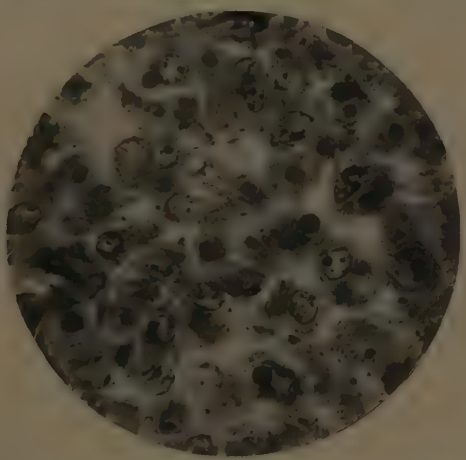

FIG. 114.—SECTION FROM TISSUE REMOVED DURING A PARTIAL HYPOPHYSECTOMY FOR ACROMEGALY. (A. E. Halstead.)

The section is typical of the hyperplasias or strumas associated with the disease.

Cases of acromegaly have been reported by Dallemagne, Labadie, Lagrave and Deguy, Bonardi, Mitchell, Hutchings, Fetepell, Klippel, Huchard and Launois, Widal, Roy and Froin, and Petren in which there has been no enlargement of the hypophysis. In the cases observed by Mitchell, Huchard and Launois, and Petren there were no microscopic changes. These cases have been used as an argument against the hypophyseal origin of acromegaly. All of these cases are open to doubt, for in some instances a careful histologic examination had not been made, and, besides, when they were studied, nothing was known of the pharyngeal hypophysis to which attention has but recently been directed.

Haberfeld's observations in this connection are exceedingly important. He has found almost constantly hypophyseal tissue in the vault of the pharynx, which is not to be regarded as embryonal rests which have undergone partial regressive changes, but as active hypophyseal tissue,

which is able to perform a function similar to the anterior lobe of the gland occupying the sella turcica.

The cases of acromegaly in which no changes have been found in the hypophysis cannot be used as an argument against the hypophyseal origin of the disease, for even in cases in which a careful histologic examination has been made, a search for and examination of the pharyngeal hypophysis have not been made. The important rôle that misplaced hypophyseal tissue may play in the etiology of acromegaly is indicated by a case reported by Erdheim. The patient was an old man who had died of meningitis following otitis media after having had acromegaly ten or fifteen years. At the autopsy a perfectly normal hypophysis was found, but when the examination was continued a tumor was found hidden in the body of the sphenoid, which was composed exclusively of eosinophile cells corresponding in every way to those found normally in the anterior lobe of the hypophysis. This tumor had broken into the floor of the sella and was regarded as malignant, an adenocarcinoma of an accessory anterior lobe composed entirely of chromophile cells.

As yet no case of undoubted acromegaly has been reported in which there has not been found a lesion of the anterior lobe of the hypophysis or of tissue histologically and physiologically its equivalent. The changes in the hypophysis consists of hyperplasia or adenoma formation, the chromophile cells being the ones involved in almost all cases. The hyperplasia or adenoma may become malignant or undergo cystic degeneration. These pathologic changes usually coincide with the cachectic stage of the disease.

Sarcomata, osteosarcomata, and other mesoblastic tumors occur in the anterior lobe, but they are rare. In a case reported by Hagenbach a sarcoma was found. This was associated with osteogenesis imperfecta.

Tumors of the Gland Unassociated with Acromegaly.—Most of the tumors of this group are found about the infundibulum and in the infundibular region. In discussing tumors of the anterior lobe the occurrence of chromophile and chromophobe adenomata without acromegaly has already been noted. The symptoms caused by these tumors are usually due to pressure, and constitutional symptoms may not develop until late.

Creutzfeldt's statistics would seem to indicate that tumors developing from craniopharyngeal duct inclusions (Erdheim's Hypophysenganggeschwülste) are the most common growths of the hypophysis unassociated with acromegaly.

The following table indicates the frequency of the different varieties of tumors of the hypophysis without acromegaly in 55 cases:

Number of cases.	Character of tumor.	Per cent.
19	Craniopharyngeal duct inclusions.	34.54
15	Sarcomata.	27.27
5	Hyperplasias.	9.09
3	Strumas.	5.45
10	Adenomata.	18.18
1	Metastatic tumor from thyroid gland.	1.818
1	Teratoma.	1.818
1	Lipoma.	1.818

Tumors Developing from Craniopharyngeal Inclusions or Rests of Buccal Epithelium (Erdheim's Hypophysenganggeschwülste).—This group comprises the most common tumor of the infundibulum and infundibular region. They appear in the literature under a number of different terms, such as epithelial tumor of the infundibulum and third ventricle, papilloma of the choroid plexus of third ventricle, cystic endothelioma developing from the pia mater, epithelioma of the Malpighian type, adenoma and adenosarcoma of the hypophysis.

Saxer in 1902 described an epithelial tumor which replaced the infundibulum, filled up and distended the recessus infundibuli and recessus opticus, and extended into the floor of the third ventricle so as to form a part of its floor, also into the lateral ventricle through the foramen of Monro. The anterior lobe of the hypophysis was normal and the tumor was unconnected with the choroid plexus. The nodular free surface of the growth, especially that projecting into the third ventricle, had a definite papillary structure. The papillæ consisted of a fairly thick connective-tissue groundwork which was covered by epithelial masses, the general arrangement of which corresponded to that of flat epithelium. The most superficial epithelial layers consisted of flattened cells which were fusiform on cross-section. The deeper layers were cubical or cylindrical and the cytoplasm of the cells was markedly vacuolated.

Saxer's description is cited at some length, for it gives fairly well the characteristics of this group of tumors. Tumors with the same characteristics had been described by Ingermann, Höhl, Engel, Rokitansky, Ziegler, and others. Ingermann had noted intercellular bridges, had described liquefaction of the cells and stroma, ending in the formation of pseudocysts, and had noted that histologically the tumors were very similar to adamantinomata occurring in the jaw, but did not recognize the origin of these growths.

Erdheim was the first to recognize that a number of growths which had been found about the infundibulum and had appeared in the literature under a number of different terms belonged to one group. In 1904 he published a monograph dealing with 7 cases which he had studied personally and with 12 cases which were found in the literature. Among the 12 found in the literature, 4 were solid, and 8 cystic, tumors. Erdheim, in examining his cases, found cells with distinct intercellular bridges which resembled closely those of stratified, flat epithelium. Histologically, these tumors bear a striking resemblance to adamantinomata of the jaw, tumors developing from the enamel organ. They have the same tendency to liquefaction and cyst formation, they occur in young people, and although apparently often malignant upon histologic examination, they have but little tendency to form metastases.

The walls of the cystic tumors are often covered by papillary excrescences, as indicated in Fig. 115. The contents of such a cyst may be serous, mucoid, or hemorrhagic. Occasionally a hemorrhage may occur in such a cyst, leading to a sudden aggravation of symptoms.

In 1910 Lewis collected from the literature 29 tumors belonging to this group. There were probably a number of others, but the histologic re-

ports were so meager and imperfect that some of the tumors, which probably belonged to this group, could not be placed in it without the possibility of error. Since then a number of cases have been reported or observed by Mixter and Quackenboss, Kanavel, Strada, Blackburn, and others.

Tumors of this group pass early out of the sella turcica, along the floor of the third ventricle, and encroach upon the optic nerves, which may be stretched ribbon-like over the tumor invading the interpeduncular space.

FIG. 115.—CYSTIC TUMOR OF THE INFUNDIBULUM ARISING FROM NESTS OF BUCCAL EPITHELIUM SUCH AS IS REPRESENTED IN FIG. 111. (Erdheim.) (Reproduced from Erdheim's monograph, Über Hypophysenganggeschwülste.)

a, Anterior pole of tumor encroaching upon the optic chiasma and both frontal lobes (*St*); the posterior end of the cyst covers the pons (*P*). The cyst had transparent thin walls and was filled with clear serous fluid. A transverse constriction is seen at *F*, which is due to pressure of the posterior wall of the sella turcica. Directly in front of this furrow is the anterior lobe of the hypophysis (*H*), which is of normal size, but somewhat flattened. Its upper surface is closely adherent to the under wall of the cyst. The lower wall of the cyst has been partly removed to permit of a view of the interior. Most of the inner surface is smooth and shiny. Upon the upper wall a mass of papillary excrescences (*Pe*) measuring 2 cm. in width and 2½ cm. in length may be seen. Most of these have broad bases; vegetations with long thread-like pedicles are rare.

The average age at which they have been observed is thirty-two years: the youngest patient was nine years of age, the oldest, sixty-three.

We shall see later, when discussing the diagnosis of tumors of the infundibulum and infundibular region, that these tumors are frequently associated with Fröhlich's syndrome. Erdheim believes that this syndrome is not due to any interference with the function of the hypophysis, but that it is the result of pressure exerted upon certain centers at the base of the brain. He has noticed that this syndrome is most often associated with tumors which grow out of the sella and extend to the base of the brain, and with those tumors which have not developed in the

sella or from the hypophysis proper, but from the infundibulum. In support of this view he cites a number of cases, such as those of Selke, Boyce and Beadles, Babinski, Cestan and Halberstadt, and Gläser. The view advanced by Erdheim is supported by Bartels.

Fischer has advanced the theory that adiposity with sexual infantilism is due to a destruction of the posterior lobe. Lewis in 1910 suggested on pathologic grounds that these changes were due to interference with, or loss of secretion of, the pars intermedia. Cushing in his last report states that (for reasons which have been given in discussing glycosuria associated with hypophyseal disease, and contrary to the opinion advanced in a

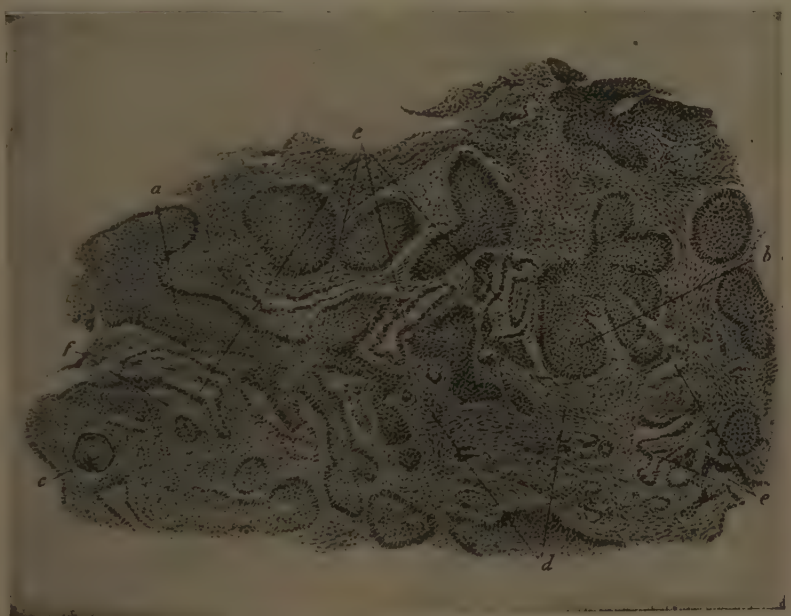

FIG. 116.—SECTION FROM A TUMOR DEVELOPING FROM THE NESTS OF BUCCAL EPITHELIUM IN THE INFUNDIBULUM. (Erdheim.) (Reproduced from Erdheim's monograph Über Hypophysengang-geschwülste.)

Histologically this tissue resembles closely that of adamantinomas of the jaw (*e*, *e*), small cysts lying between the strands of flat epithelium. Defects of varying extent are often found in the walls of these cysts, which, as a consequence, are often collapsed and irregular in shape. They are usually lined with a single layer of low epithelium (*f*). The stroma for the most part is of the fetal type and is composed of numerous fusiform connective-tissue cells (*d*), arranged in the form of bundles. The stroma resembles quite closely that found in the "sarcoma phyllodes" of the breast.

previous paper by Crowe, Cushing, and Homans) the tendency toward adiposity displayed by partially hypophysectomized animals is not due solely to deficiency of anterior lobe secretion.

In internal hydrocephalus the floor of the third ventricle often bulges downward like a cyst and compresses the posterior lobe of the hypophysis. Fischer believes that the adiposity with sexual infantilism observed in some of these cases due to direct pressure upon the posterior lobe, while Cushing believes it due to the failure of posterior lobe secretion to pass into the cerebrospinal fluid, with which it is supposed to pass into the dural sinuses.

Tumors of the Pars Intermedia.—It is only recently that the possibility of tumors developing from the pars intermedia has been suggested. Cushing, in an article published in 1911, stated that Crowe, while studying sections of a large adenomatous tumor at the base of the brain removed from an excessively obese individual who had died of pressure effects, found a normal though compressed anterior hypophyseal lobe with undoubted evidence that the growth originated from the pars intermedia alone. The vesicles contained colloid and the tumor resembled in its arrangement one which might have arisen from the thyroid gland.

Descriptions are found in the literature of three tumors which have probably developed from cells invading the nervous lobe, regarded by many as invasions from the anterior lobe. We have already discussed these cells and stated why we believe that they should be regarded as cells of the pars intermedia. Boyce and Beadles and Erdheim have described small tumors which were found during routine postmortem examinations, and had given rise to no symptoms which undoubtedly developed from the basophilic cells found in the pars nervosa. Recently Notdurft has reported a basophilic adenoma of the hypophysis, in a man fifty years of age, which lay in the neurohypophysis. The tumors described by Boyce and Beadles and Erdheim were both small. They occurred in women aged seventy-four and eighty-six respectively, and were discovered accidentally during routine postmortem examinations. No clinical data are given concerning Notdurft's case.

Teratomata, Lipomata, Chordomata, and Other Rare Tumors of the Hypophysis and Infundibular Region.—Teratomata of the infundibular region or hypophysis have been described by Beck, Benda, Kon, Cushing, and Hecht. The one described by Beck occurred in a woman seventy-four years of age who died of senile marasmus and atrophy of the kidneys. It measured 25 x 27 x 24 mm. In it, besides remnants of hypophyseal tissue, were found trabeculæ of bone, cysts lined with ciliated epithelium, and 14 teeth. The tumor described by Benda occurred in a dwarf thirty-seven years of age. In Kon's case flat epithelium, glia and collagenic fibers, bone, and tissue resembling that of the notochord were found, while in that reported by Hecht epithelial elements from the anterior lobe of the hypophysis and osteoid tissue, very probably derived from an embryonal inclusion, were found.

Margulies has reported a teratoma in the hypophyseal region of a rabbit.

Chordomata.—Recently Spiess has reported an operation upon a man twenty-eight years of age, who complained of headache which has persisted for three months, and gradual loss of vision, a bitemporal hemianopsia developing. These symptoms were apparently caused by a tumor of the infundibular region. The tumor was operated upon by the endonasal routes, and pieces of it which were removed were examined by Bernhard Fischer, who made a diagnosis of a chordoma. This case and the one just reported by Kon, which was mentioned above, are the only ones in which tissue apparently developing from inclusions of the notochord

has been found. These findings are of interest in connection with Spetzer's theory as to the etiology of acromegaly, which has, however, no anatomic basis. Spetzer believes that the notochord has a directive and stimulating influence upon bone growth, and that acromegaly might be caused by the proliferation of chordal elements which have become included in the hypophysis during torsion of the cephalic end of the embryo.

Lipomata of the infundibulum and floor of the third ventricle have been reported by Weichselbaum and Fischer. In the case reported by Fischer, adiposity was a prominent clinical feature.

A perithelioma of the infundibulum has been reported by Kon and a peculiar angioma by Pechkranz. Such tumors are exceedingly rare and are but little more than pathologic curiosities.

Metastatic growths in the hypophysis are rare. A carcinoma of the stomach with secondary deposits in the hypophysis has been reported by Schupfer, and a carcinoma of the breast with hypophyseal metastases by Thoinot and Delamare. Simultaneous involvement of the thyroid gland and hypophysis by tumors have been reported by Wolff, Rosenhaupt, Windemann, and Becker.

Gummata and tubercles of the hypophysis have been reported by a number of different investigators. The hypophysis is so well protected that it is rarely injured. Madelung has observed a case in which after a gunshot wound of the skull, the bullet as revealed by the *x*-ray picture had apparently lodged in the sella turcica, Fröhlich's syndrome developed.

The enlargement of the bones which occurs in acromegaly is mostly due to periosteal proliferation, which leads to an increase in the size of bony prominences and ridges, crests and tuberosities, and depth of the grooves for the transmission of blood-vessels, tendons, and nerves. In some cases osteoporosis has been observed. The skull bones in some instances are covered by osteophytes, while the external occipital protuberance, the mastoid processes, and the orbital ridges become greatly increased in size. The air-sinuses are enlarged and a kyphosis of the cervical and upper dorsal region develops. The glenoid cavities usually become larger and deeper than normal and wider apart.

Postmortem examinations have shown that the enlargement of the extremities is not entirely due to periosteal proliferation. The subcutaneous tissue is thickened by proliferation of connective tissue which grows around the fat lobules, in some instances forming distinct fibrous masses.

Splanchnomegaly, hypertrophy of lymphoid tissue with a large persistent thymus, degeneration and atrophy of the muscles, dilatation and hypertrophy of the left heart with degeneration of blood-vessels, and changes in the central nervous system have all been noted in acromegaly.

The pathologic anatomy of Fröhlich's syndrome will be noted under the symptoms and diagnosis of the same.

Symptomatology.—Definite clinical phenomena are associated with alterations in hypophyseal secretion. As these are usually associated with a tumor, the symptoms of hypophyseal disease should be considered from a general and local viewpoint. The general clinical phenomena associated with hypophyseal disease are acromegaly due to excessive secretion of the anterior lobe of the gland and Fröhlich's syndrome (dystrophia adiposo-genitalis), due to lessened secretion of a part of the gland, the part involved not being agreed upon by all. In quite a number of the cases of acromegaly symptoms associated with Fröhlich's syndrome are found. It is not uncommon to find this combination.

Acromegaly.—When well developed the clinical features of acromegaly are so definite that the disease is rather readily recognized. The facial expression is apt to be dull, the hands and feet become large and bulky, the nose large and broad, and the lips thick. The tongue may become so large that it protrudes from the mouth. The large jaw projects forward and often the teeth become separated as it enlarges. The head seems to sink in between the shoulders as a kyphosis of the cervical and dorsal vertebra develops. Changes in the size of the hands, feet, and head are indicated by the larger shoes, gloves, and hats required. Acroparesthesia may develop, and ocular palsies, due to direct pressure upon the nerves by the enlarging tumor, may occur. Depending upon the direction in which the tumor grows, various symptoms associated with a brain tumor will develop. The symptomatology of acromegaly is fully discussed in Sternberg's monograph and by Dock in Osler's "Modern Medicine."

Among the general symptoms, amenorrhea, or impotence, and glycosuria demand especial attention, for they may occur early in acromegaly, often before the alterations in growth become pronounced or the cerebral symptoms develop. In some cases of acromegaly amenorrhea is the first symptom, often antedating by years other general symptoms associated with a disease. In a case recently observed by A. E. Halstead, cessation of menstruation antedated by ten years other symptoms. In some cases menstruation ceases at once and does not return, while in other cases it ceases after impregnation, but does not appear after delivery. Often after ceasing supposedly after exposure to cold, it returns after fifteen or eighteen months for a few periods and then ceases permanently. In man impotence may be the first indication of hypophyseal disease. Amenorrhea or impotence when associated with symptoms of an intracranial growth become suggestive of hypophyseal disease.

In discussing the relation of the hypophysis to other glands we have mentioned that glycosuria, according to different investigators, occurs in from 11 to 40 per cent. of all cases of acromegaly, and have discussed the theory offered by Cushing in explanation of the same.

Relation of Acromegaly and Gigantism.—According to Sternberg, about 20 per cent. of all acromegalics are over 5 ft. 10 in. in height and about 40 per cent. of all giants have acromegaly. Massolongo believes that acromegaly is nothing but delayed abnormal gigantism. Meige has accepted this view and states that when the disease begins in youth

gigantism results, when in adult life, acromegaly; while if beginning in youth and continuing into adult life, a combination of the two develops. The relation of acromegaly and gigantism is fully discussed by Bassoe in an article dealing with Gigantism and Leontiasis ossea, with report of the case of the Giant Wilkins.

Acromegaly is usually a chronic disease covering a course of from ten to fifteen years or more. Three types, depending upon the length of clinical course, have been described by Sternberg: (1) The benign form, which may last fifty years and be associated with but few symptoms; (2) the commonest form of chronic acromegaly, lasting from eight to thirty years, and (3) the acute, malignant form, with a relatively short clinical course of three or four years. Sternberg, in discussing the acute malignant cases, says that they develop very quickly, the enlargement of the terminations of the extremities succeeding one another under the physician's eyes. In a few weeks the changes in the features have astonished the observer. According to him, the most interesting point in the acute cases is that a true sarcoma of the hypophysis is found. This statement concerning the character of the growth even in the acute cases is probably incorrect, for acromegaly is not associated with destructive connective-tissue growths of the gland.

During the course of the chronic cases there may be remissions in the symptoms and actually improvement in the condition. Death may occur suddenly and unexpectedly as in other brain diseases, or the patients, after passing into a cachectic stage, probably associated with cystic or malignant degeneration of the tumor, may die of a terminal infection such as pneumonia. In some cases diabetic coma has caused death, in other cases death has been due to tuberculosis contracted as the result of lowered resistance.

Women are apparently afflicted somewhat more frequently than men. Sternberg, in computing the statistics relating to 125 cases, found that the disease occurred 55 times in men and 70 times in women. The earliest cases reported have developed during the fourteenth or fifteenth year. Cases which have been reported in children are doubtful. Solge has recently reported a case of congenital acromegaly. The child died when two and one-half years old. A heart lesion was found at autopsy and a tumor of the hypophysis composed of eosinophile cells. An *x*-ray examination revealed changes at the base of the skull. Benda doubted whether this case should be regarded as one of congenital acromegaly.

Fröhlich's Syndrome (Dystrophia-adiposo-genitalis).—Fröhlich in 1901 directed attention to a remarkable physical state when he described the clinical phenomena occurring in a boy fourteen years of age, who presented the symptoms of a brain tumor associated with adiposity and lack of development or atrophy of the external genitalia. The symptoms began in this boy when he was eleven and one-half years old with headache and vomiting. The boy, who was relatively slim before the symptoms began, commenced to take on weight rapidly, so that when fourteen years of age he weighed about 110 pounds, whereas the average

weight of a boy of this age is from 78 to 85 pounds. The skeleton was in no way affected and the increase in weight was apparently due entirely to an accumulation of fat, the deposits of which were most marked about the abdomen and the genitalia. The penis in this case was small and hidden between masses of fat, so that the external genitalia resembled those of the female. The testicles were of infantile proportions. Collections of fat were also found about the genitalia. There was no axillary hair and only a few isolated hairs about the genitalia. The hair of the head was short and scanty and had continued to fall out since the beginning of the disease.

Isolated reports of tumors about the hypophysis in which adiposity had been one of the marked clinical features are found in earlier literature. Mohr in 1841 reported such a case. Fröhlich was the first, however, to recognize that these cases presented a definite syndrome, probably associated with alterations in hypophyseal secretion.

The number of reports of cases of dystrophia-adiposo-genitalis have increased rapidly during the past few years. In 1909 Frankl-Hochwart tabulated and reported the findings in 155 cases, including several which had been observed by Fröhlich or himself. These patients usually present the symptoms of brain tumor, such as headache, vomiting, and visual disturbances, consisting of a primary optic atrophy and unilateral or bilateral temporal hemianopsia due to direct pressure of the tumor upon the optic tracts or chiasma. Associated with these symptoms caused by the enlarging tumor are retarded sexual development or loss of secondary sex characteristics, and the development of adiposity. The fat is not deposited symmetrically, but is most pronounced over the buttocks, about the genitalia and the breasts, so that in the male the female form is often simulated.

When the syndrome begins before puberty the characteristics of early childhood or infancy are preserved, while if it develops after growth has been completed, we have the " reversive infantilism of Gandy or the tardy infantilism of Brissaud and Bauer." In this type of infantilism, besides the peculiar skin changes more or less suggestive of myxedema, there are found sexual changes, such as atrophy, amenorrhea, or impotence, loss of axillary and pubic hair and of secondary sex characteristics. As in acromegaly we have different types depending upon whether the disease begins before or after growth is completed, so in Fröhlich's syndrome we have different types depending upon the same relation. The earlier the syndrome develops, the greater the tendency to and the more marked the adiposity. The theories as to the cause of Fröhlich's syndrome have been discussed in the section dealing with Tumors of the Infundibulum and Infundibular Region.

One of the most interesting clinical features of Fröhlich's syndrome is the frequency with which polyuria, in some instances a true diabetes insipidus, occurs. This has been noted in about 7 per cent. of the reported cases. In discussing the physiology of the posterior lobe the presence of a diuretic substance in it has been noted. This substance is probably secreted by the pars intermedia. Hypersecretion of the

pars intermedia as the etiology of diabetes insipidus is the most satisfactory of any yet suggested.

Combined Types.—It is not at all uncommon to find a definite part of the clinical picture of Fröhlich's syndrome in acromegaly. In statistics which have recently been prepared from a series of acromegalies, atrophy of the genitalia occurred in 36.4 per cent. Amenorrhea or impotence, as has already been noted, is often one of the early symptoms of beginning acromegaly. Adiposity in acromegaly is much rarer than disturbances of genital function. According to Creutzfeldt, adiposity has been noted in but 1.6 per cent. of the cases of acromegaly. Fischer believes that these figures are too low, for a number of cases of acromegaly have been reported in which adiposity was marked enough to attract the attention of the clinician.

Cushing has explained this combined picture on Marine's theory regarding the simultaneous occurrence of symptoms of hyperthyroidism and myxedema in cases of exophthalmic goiter. It must be admitted that glandular activity is often followed by pathologic glandular sluggishness or regressive changes. In acromegaly, however, the genital disturbances, even the adiposity, may be one of the earliest symptoms, developing often before definite symptoms of overactivity on the part of the anterior lobe. It is difficult to see how the gland can be over- and underactive at the same time. This combined type, it seems to us, can be best explained by assuming that the growth associated with acromegalic symptoms has interfered with another part of the gland, such as the pars intermedia, with a different function. The pars intermedia has never been carefully studied in those cases of acromegaly in which genital disturbances and adiposity formed a prominent part of the clinical picture.

Local Symptoms.—These depend upon the direction in which the tumor enlarges. A tumor may enlarge downward without giving rise to symptoms due to pressure on the optic nerves. Tumors of the infundibular region involve the optic nerve early, so that unilateral or bilateral hemianopsia may be one of the earliest symptoms. If the tumor grows posteriorly, spasticity may develop from pressure on the crura, while disturbances of smell and taste follow involvement of the uncinate gyrus, and mental disturbances, involvement of the frontal lobe.

Choked disc is apparently much less common with hypophyseal than other intracranial growths. Bartels has collected 40 cases of tumors of the hypophysis and studied their relation to choked disc. In 50 per cent. of these there was simple bilateral atrophy and one unilateral atrophy, in 15 per cent. double choked disc, in 15 per cent. neuritis with subsequent atrophy, and in 10 per cent. there was no change at all. The visual defect is almost always bilateral. According to Uhthoff, paralysis of the ocular muscles occur in 25 per cent. of the cases. The third nerve is the one most frequently affected. Among 31 cases of ocular palsies associated with hypophyseal growths, the third nerve was affected not less than 28 times. Often the paralysis is partial, only the levator palpebræ being affected. The sixth nerve is rarely involved, and at

the time Uhthoff made his report there were no isolated instances of paralysis of the fourth nerve.

X-Ray Examination of the Sella Turcica.—Since Oppenheim in 1899 demonstrated a widening of the sella turcica with a hypophyseal growth, numerous articles have been published upon the appearance of the base of the skull under normal and pathologic conditions.

Under normal conditions the bony boundaries are very distinct in *x*-ray pictures, and the cavity in the sella turcica seems to be constricted above by the approximation of the anterior and posterior clinoid process. The sella gradually enlarges when the hypophysis is the seat of a tumor, and disappearance of bone or osteoporosis can be made out early. These bone changes appear early and are usually most pronounced in the posterior clinoid processes and clivus.

The changes in the contour of the sella depend upon the direction in which the tumor enlarges. A tumor may enlarge downward and destroy the floor of the sella, invading the sphenoidal sinus, and later the nasopharynx. In another case the tumor may grow backward, destroying the posterior clinoid process and the back of the sella, while in other cases, such as tumors of the infundibulum, the growth enlarges upward, thus widening the entrance to the cavity of the sella.

Treatment.—The treatment of diseases of the hypophysis should be considered as both medical and surgical. At present medical therapy confines itself to treatment after the removal of tumors. It is possible, however, that certain types of hypopituitarism and dyspituitarism may ultimately be regulated by the extracts of this or other glands of internal secretion.

The gland may be approached for surgical procedures by two routes. These may be classified as follows:

A. Intracranial.
   1. Through the anterior fossa.
   2. Through the temporal fossa.

B. Transphenoidal.
   1. Through the nose.
      a. Supranasal.
      b. Infranasal.
   2. Through the mouth.

The transphenoidal has been the route of choice in the majority of operations performed up to this time.

The Intracranial Route.—1. *Through the Anterior Fossa.*—Kiliani suggested the possibility of raising a bilateral frontal bone and dural flap. The anterior lobes were then to be raised. In one case where this procedure was used by McArthur, Church reports that there was considerable laceration of brain tissue, and although a tumor was removed, the patient succumbed within a few hours.

Krause has suggested an extradural route by which a unilateral frontal bone-flap is made, the frontal lobe is raised, and the dura incised in the neighborhood of the anterior clinoid process. Borchardt attempted this, but desisted because of the excessive hemorrhage. Bogo-

jawlensky has reported a case operated upon successfully by a modified Krause method. The operation was done in two stages: At the first step a bone and skin flap was made of the right frontal bone; one leg of the triangle lying parallel with the orbit and 2½ cm. above it, the other lying 2½ cm. from the median line and being 9 cm. long. The bone was removed along these lines, but the flap was not raised. Later the flap was raised and the dura incised along parallel lines; the dural flaps being turned up and down respectively. The brain was then easily raised and the tumor protruding above the optic chiasm was removed with a sharp curet. The patient made a satisfactory recovery.

McArthur has recently operated upon a case by removing one superior orbital ridge and preserving it in normal salt solution. The part of the orbital roof remaining was then removed down to the optic foramen. The dura was then incised and the tumor protruding from the sella turcica removed by the curet. The preserved orbital ridge was replaced in position and the wound closed.

2. *Through the Middle Fossa.*—Caton and Paul originally suggested this route, and it has been used by Horsley in his cases. His results have not been published. Dalgren and others have attempted to use this route, but were compelled to desist because of hemorrhage.

Silbermarck, following cadaver experiments, has recently suggested an operation by bilateral craniotomy, after the method used on dogs by Cushing. This allows the brain to be dislocated more easily.

The Transphenoidal Method.—The credit of bringing this method before the profession should be given to Schloffer, although it is probable that the original Schloffer method will be employed but seldom in the future.

Supranasal Routes.—Schloffer turned the nose to the right, excised the turbinates, the ethmoid cells, and the septum, removed the inner wall of the left orbit down to the optic foramen and the inner wall of the antrum of Highmore, with a portion of the nasal projection of the left superior maxilla, and then removed the tumor through the sphenoid cells.

Von Eiselsberg and Hochenegg operated without removing the orbital or antral wall. The latter makes an osteoplastic flap of the bone over the frontal sinuses. They have operated upon several cases by this method.

Löwe suggested several plans, the one which he most strongly urged being the making of a longitudinal incision a little to one side of the median line of the nose. The bone-flaps are then turned back, the ethmoid cells, turbinates, and septum are removed, and the sphenoid entered.

Moskowicz and Tandler proposed to make an incision along the side of the nose and to turn it to one side. The operation then proceeded through the supranasal region. They proposed to secure more room at times by the removal of the nasal process of the superior maxilla and the under wall of the frontal sinuses. The operation was performed in two stages: the first part carried the operation down into the sphenoid cells as described above; a flap of skin was then secured from the forehead and

turned in along the cribiform plate, the tip reaching into the sphenoid cells. This was done with the idea of preventing meningitis. At the second operation the floor of the sella turcica was broken down and the tumor removed.

Chiari reports 2 cases upon which he operated by a modification of Schloffer's method. The periosteum was lifted off of the frontal process of one side of the nose and from the inner wall of the orbit, the bones were then resected with portions of the ethmoid and intranasal structures. While this route is somewhat shorter, it is questionable if it is superior to the other supranasal routes.

Kocher made an incision so as to separate the cartilaginous from the bony nose. The nasal bones were then separated in the middle and

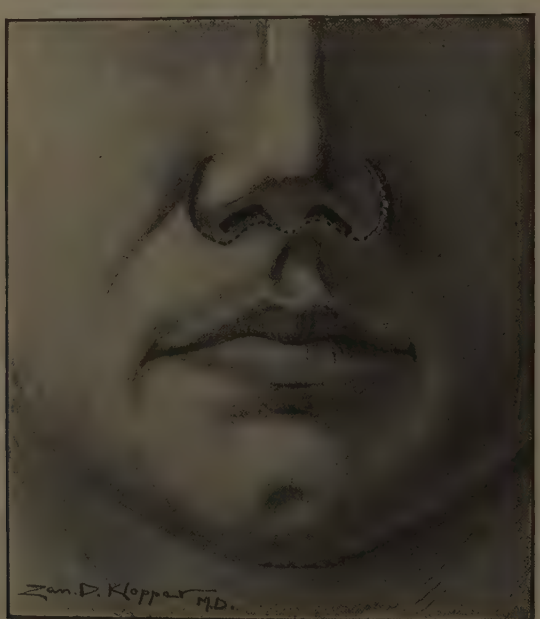

FIG. 117.—SHOWING LINE OF INCISION UNDER NARES AND INCREASE OF ALÆ. (Kanavel.)

turned one to each side, making a double trap-door. The succeeding steps do not differ from the Von Eiselsberg procedures.

Infranasal Routes.—This route was proposed by one of us (Kanavel) as much simpler and safer than those which proceed by the superior part of the nose, as in the Schloffer method. It was argued that the supranasal route necessitated a disfiguring scar and the removal of the ethmoid cells and the septum. These undesirable results were avoided by the infranasal route, and, moreover, the danger of infection through the cribiform plate and of excessive hemorrhage were avoided. These results have all been borne out by experience. By the method proposed, a skin incision is made in the crease of the alæ of the nose and close under the nares (Fig. 117). The nasal spine is then cut with the bone forceps,

the nose entered, and with a Ballenger swivel knife the cartilaginous septum is cut from its base and from the perpendicular plate of the ethmoid (Fig. 118). This permits us to turn the nares with the attached cartilage upward. The bone of the septum lying in the line of the sphenoid cells is then removed by bone-biting forceps. If the cells are not entered when tearing the septum away, their location is determined by the foramina and they are entered by a chisel. The anterior wall is removed by a Schmittheusen punch forceps; the sella is then entered by means of a chisel and the shell of bone removed in the same manner. It may be necessary to remove the inferior and middle

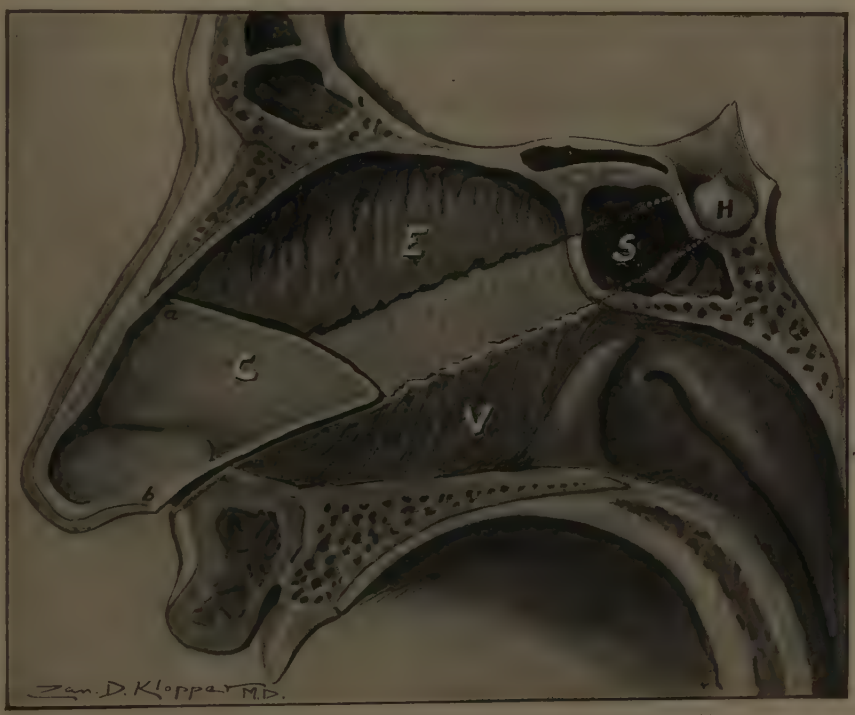

Fig. 118.—Showing Technic of Infranasal Approach. (Kanavel.)
V, Vomer; *E*, perpendicular plate of the ethmoid; *C*, cartilaginous septum; *S*, sphenoid cells; *H*, hypophysis; *b–a*, line of incision of cartilage.

turbinates, in which case a two-step operation should be done, the turbinates being removed under cocain a few days previous to the major operation. Halstead (A. E.) modified this procedure by making the primary incision at the labiobuccal groove under the upper lip. The nose is then raised with the adjacent muscles of the face (Fig. 119). The succeeding steps are as described above. This work was done independently of Löwe, whose general suggestion of the same route had never been followed up. The credit for the procedure should be given to Halstead, who used and popularized the method. Fien later suggested the same technic as Halstead, except that, in addi-

tion to the other structures, he removed one wall of the antrum of Highmore.

Various other methods of approach have been suggested, such as splitting the superior maxilla, and separating the hard from the soft palate, with or without dividing the inferior maxilla at the symphysis. Löwe has suggested making an incision between the angle of the jaw and the base of the tongue, where few structures would be severed. This gives ready access to the nasopharynx. Unfortunately, however,

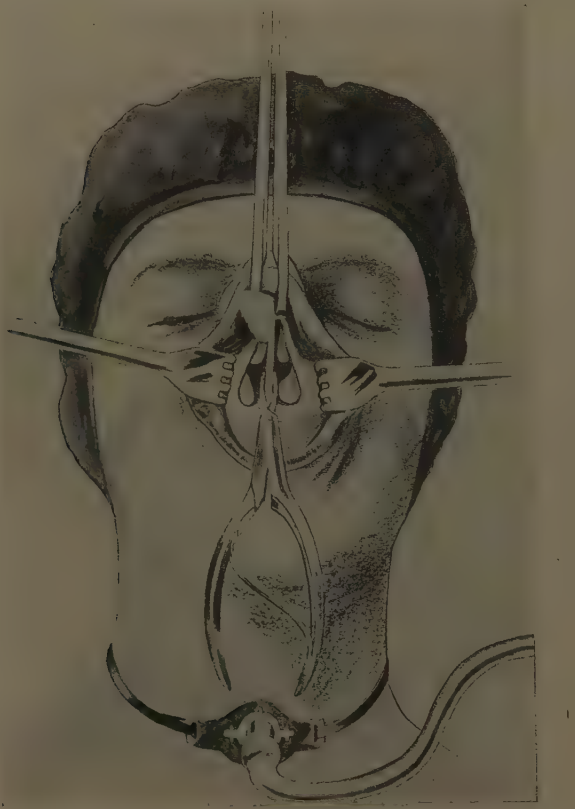

FIG. 119.—HALSTEAD'S METHOD OF APPROACH.
Nose and lip retracted after division of septum. Turbinate bodies exposed.

this strikes the sphenoid cells and the sella at an oblique angle, making the operation here difficult or impossible.

The operation of Hirsch should be considered in a separate class. He operates under local anesthesia in several stages.

In his earlier cases he removed the inferior and middle turbinates at the first sitting; at the second, the anterior and posterior ethmoids; at the third, the anterior wall of the sphenoid with the impinging septum, and at a fourth, the anterior wall of the sella turcica. The tumor was then removed by a curet. Later he suggested the submucous route

and urged it as a means of lessening the dangers of infection. He has described his technic as follows:

"The mucous membrane of both sides of the nasal septum is desensitized with a 20 per cent. cocain solution. An incision is now made along the anterior edge of the quadrangular cartilage, through the mucous membrane of one side, down to the cartilage, and the mucous membrane is raised by means of a raspatorium, together with perichondrium and periosteum, from the cartilage and bone. The cartilage is now incised ½ cm. from the original incision and a raspatorium slipped between the perichondrium and the cartilage and carried to the posterior border of the septum; the mucous membrane, together with the perichondrium and periosteum, are now raised from cartilage and bone on this side. The membranes are now held apart by a nasal speculum and in this way a medial nasal cavity formed in which one sees the bare cartilage. This is removed with one sweep of the cartilage knife, and the vomer and the perpendicular plate of the ethmoid are resected with the aid of a bone forceps. Up to the present this operation is identical with Killian's submucous septum-resection.

"To bare the wall of the sphenoidal cavity it is necessary that the mucous membrane of the vomer where it joins the sphenoid be separated from the bone. This is very easily done, after which the mucous membrane is separated from the anterior surface of the sphenoid on both sides as far as the ostium sphenoidale, so that the raspatorium falls into the sphenoidal cavity. Now through this sack of mucous membrane one removes the posterior part of the vomer and the rostrum sphenoidale with the bone forceps, and with several strokes of a chisel one breaks through the anterior wall of the sphenoid cavity, and after removing the sphenoidal septum one sees the hypophyseal prominence in its entirety.

"After opening the sella turcica and the dura of the hypophysis respectively, the hypophyseal tumor lies free in the sphenoidal cavity."

Choice of Operation. Intracranial Versus Transphenoidal.—At the present time one cannot say definitely which procedure will be the one of choice. Certain general principles can be laid down, however, and the lines of future work suggested.

The transphenoidal route cannot, unfortunately, be rendered absolutely aseptic, therefore meningitis is always a possibility, although that menace is growing less as our experience accumulates. One cannot remove all the tumor when it has extended widely outside of the sella turcica. The route is not available for tumors lying in juxtaposition to the hypophysis, and hence giving rise to hypophyseal symptoms.

The intracranial route is not feasible for tumors confined to the sella turcica. It can be only palliative in a majority of cases, since it does not become the operation of choice until the tumor is far advanced, and in most cases it will be impossible to remove the part of the tumor lying in the sella turcica.

Therefore, we may say that tumors lying for the most part in the sella turcica should be reached by the transphenoidal route. Cysts may be reached and drained by either route, but more permanent results

may be hoped for from the transphenoidal route, since this affords room to grow and makes subsequent puncture and drainage easy. Tumors that have surely grown beyond the sella turcica can be reached by the intracranial route. Neighborhood tumors may be reached in the same manner. In this connection it should be remembered that in case of future growth the transphenoidal route gives a decompression opening for the local structures as well as for the brain, while the intracranial, in a majority of cases, gives relief for general brain pressure only. In general then, in old cases in which palliation only is sought, the intracranial route is the operation of choice; in those in which we hope for permanent results we must use the transphenoidal, although the danger of infection is greater. It is to be hoped that the future may suggest some intracranial route that will offer permanent relief with a minimum of danger.

Choice of Individual Operation.—Not enough operations have been attempted by the intracranial method to choose between them. Horsley has apparently had good results with the approach through the middle fossa, although his immediate and ultimate results have not been published. The method of McArthur or that method combined with a preliminary Krause flap would seem to offer many advantages in extensive growths.

Of the transphenoidal methods, an experience with 3 cases leads us to reiterate the statements made in our previous papers, namely, that the infranasal approach, as described by one of us (Kanavel), or some of its modifications (Halstead, Hirsch), should be the operation of choice. While all credit should be given to Schloffer, Von Eiselsberg, Hochenegg, and others who have operated earlier by the supranasal route, when one contrasts the ease and simplicity of the infranasal approach with the mutilation, difficulty, and added danger of infection by the supranasal, the latter will surely be abandoned.

Concerning the modifications of the infranasal route, the labiobuccal incision of Halstead has given a most brilliant result in the hands of its originator. It has the advantage of leaving absolutely no scar upon the face, and the disadvantage of having the incision and operative field in the mouth. To avoid the increased danger of an aspiration pneumonia, Halstead gives the anesthetic through a tracheotomy wound.

Making the incision in the crease under the nose has the advantage of having a field entirely outside of the mouth, and the disadvantage of the scar, although in 4 cases which came under our observation this was invisible to ordinary inspection.

The operation of Fien is unnecessarily extensive.

The operation of Hirsch should receive most serious consideration. In those cases in which the tumor is small or a cyst is present, it is probable that the submucous operation can be done in stages with a minimum of danger. Yet where the nasal cavity is small, or where we wish to remove as much of the tumor as is possible, a more extensive field will be found advisable. If the method of Hirsch is employed we would suggest in certain cases the possibility of cutting the basal attach-

ment of the septum of the external nares and turning this aside. This would add materially to the room. It is possible, of course, to add the submucous principle to any of the infranasal procedures.

Indications for Operation.—The indications for operation in cases of hypophyseal disease may be classified as absolute and relative. Operation is absolutely indicated in those cases in which the tumor immediately jeopardizes the life of the individual or is causing progressive blindness. It is relatively demanded when because of perverted, increased, or decreased secretion, the well being, and ultimately, the life of the individual, is threatened. Therefore, if the tumor is growing rapidly or has grown to a large size, or if a cyst has suddenly filled, we will have pressure symptoms both locally and generally that will imperatively demand intervention. As the safety of the operation increases, the field of the relative demand will be broadened. Just how far this will extend cannot be fully stated now, when our knowledge of the perverted states is limited. However, most surgeons are in accord in believing that the adipose-genital type should be subjected to operation, and many believe that all cases of acromegaly fall into the same class. In this connection one must remember that many cases of acromegaly have already reached the neutral stage, or have passed over into the stage of hypopituitarism, hence unless operation is demanded because of pressure symptoms it may be unnecessary or even inadvisable.

Principles of Operative Technic.—*Prevention of Infection.*—Cushing and Crowe have urged the use of urotropin internally, beginning three days before operation and continuing until recovery. Experimental and clinical evidence supports the theory that this may be of benefit, but several cases which proved fatal in spite of it attest that it is not an absolute preventive of meningitis.

In a case operated upon by one of us (Kanavel) an attempt was made to prevent meningitis by prophylactic injections of antistreptococcus serum, 50 c.c. being given on the day previous to the operation. The opsonic index was determined daily. It remained normal or above until the third postoperative day, when it fell below normal. At this time a second injection of 50 c.c. was given, with the result that the index again went to above normal and remained there. At no time was there any evidence of streptococcus infection of any kind. At the end of three weeks the patient, who had set that day to return home, suddenly presented the evidence of meningitis and died four days afterward. The culture of the cerebrospinal fluid showed a pure culture of a pneumococcus.

At the time of the operation the nose should be as aseptic as possible. There should be no evidence of acute rhinitis or any infection. The nasal packing should be removed early.

Anesthesia.—If the transphenoidal operation is done, Smoler, Halstead, and others advise a preliminary tracheotomy, for the administration of the anesthetic through a tube, since several deaths have been reported as due to aspiration pneumonia.

We have given our patients the anesthetic by the rectum, after the

method described by Churchill, with absolute satisfaction. In those cases in which the wound does not communicate with the mouth, any of the methods by which the anesthetic is conveyed by a tube into the pharynx, as in any face operation, may be used with satisfaction.

Hemorrhage.—The usual postnasal plug will prevent completely the blood from running down the pharynx.

As a preliminary the nose may be packed ten minutes before the operation with a strip of gauze saturated with adrenalin chlorid, 1: 1000. Care should be taken not to use too much adrenalin, since in a prolonged operation a stage of vasodilation will follow the primary constriction, making the hemorrhage annoying. The head should be elevated and the patient placed in a half-sitting position, so that the blood will run away from rather than into the field of operation.

Illumination.—The operator will do well to provide himself with an exceptionally good light, such as the Kirstein or similar headlight. With this the operator will have little difficulty in illuminating the field of operation, especially if the room be darkened.

Drainage of the Nose.—After the operation is completed it is well to leave the posterior nasal plug in for several hours and also to pack the nose to prevent hemorrhage. The packing should be removed as soon as possible. Bismuth gauze has been the most satisfactory.

Instruments.—It is well to provide slender long instruments for use. The various sphenoidal sinus instruments used by the rhinologists will be found valuable. Where the nose is turned up, a Jansen's mastoid retractor will be of great value in keeping the field open and will dispense with unnecessary hands. A long slender chisel curved at the end at an angle of about thirty degrees will aid one in entering the sella turcica safely. On this can be marked the distance from the nasal spine to the sella turcica, as estimated from the *x*-ray plate.

Identification of Area.—No operation upon the hypophysis should be undertaken without careful study of *x*-ray plates taken at various angles. If a stereoscopic *x*-ray picture can be made it will aid materially. The relations and the probable depth of the sella turcica can be studied by these. The probable outline of sphenoidal cells can be determined, as well as the amount of bone it will be necessary to remove. Careful measurements on the *x*-ray plate of the distance from the nasal spine to the sphenoidal sinus and to the anterior wall of the sella should be made, and from these should be estimated the probable distances that will be found in the patient.

It will be well to insert a small plug of gauze or other material in the sphenoidal ostia or openings before putting the patient to sleep, since this will identify them at the time of operation and save considerable time.

The especial dangers to be contended with are that the ethmoid cells may be mistaken for the sphenoids; that we may go too low and enter the pons or medulla; that, laterally, we may enter the cavernous sinus; and above, that we may injure the optic nerve. No surgeon should attempt the operation without a thorough familiarity with the anatomy

FIG. 120.—DRAWINGS FROM VARIOUS SKULLS, SHOWING VARIOUS ANOMALIES OF THE ORDINARY TYPE OF SELLÆ TURCICÆ AND SPHENOIDAL SINUSES.

1, 2, Favorable conditions for operation; 3, absence of sphenoidal sinuses; 4, small sphenoidal sinuses; 5, thick bone surrounding sphenoidal sinuses; 6, thick bone between sphenoidal sinuses and anterior margin of sella turcica. This condition also illustrated by 6; 7, no projection of sinuses beneath sella turcica—this condition also illustrated by 6; 8, thin dorsum sellæ—see also 11 and 12; 9, irregular sphenoidal septum; 10, downward projection of the portion of the sphenoid which lodges the optic chiasm; 11, shallow sella turcica; 12, downward projection of the cribriform plate.

of the parts, especially of the more common variations from the normal, nor without rehearsing the operation on the cadaver. Theoretically, the sella should bulge into the sinus. That it frequently does not, both

operative experience and anatomic study has convinced us. When one has entered the sella, if a probe is passed under the hypophysis, one should be able to follow the floor of the sella back to its posterior wall. This is of especial aid in orientation.

The possibility of serious mistake was so apparent that one of us (Kanavel) has made an especial investigation of the subject. Through the kindness of Professor Ranson, of the Northwestern University School, Mr. Gibson, of the Anatomical Department, was assigned to this subject and made a careful study of 107 skulls, taking accurate measurements. The results of his study may be briefly summarized as follows:

In 101 of the 107 skulls examined the distance from the nasion to the sella turcica varies between 56 and 68 mm., or, in other words, a variation of about ½ inch. Those not falling within these limits measure 55, 70, 69, 51, 54, and 69 mm. The skulls having the larger measurements show in general a greater distance from the nasion to the inion. Thus the variation in the above measurements is due in part to differences in size of the entire skull, as well as to differences in the relations of parts to each other. (See Fig. 120.)

The distance from the anterior nasal spine to the sella turcica varies between 70 and 85 mm. in 92 of the skulls; 8 fall without these limits, and in 7 the spine was broken away. The variations in these measurements are partly accounted for by the great difference in the prominence of the nasal spine in different skulls.

The most striking variation in size and relations is that presented by the sphenoidal sinuses. In two of the skulls they were entirely absent and practically so in a third, there being a small cell on one side. (See No. 3, Fig. 120.) In 22 of the skulls the sinuses reduce the body of the sphenoid to a mere shell, while in 9 they occupy only a small portion of the body of the bone. (See Nos. 4, 8, and 12, Fig. 120.) This variation, however, is chiefly in their backward and downward extent, the anterior and superior boundaries being fairly constant, and the bone sufficiently thin to offer little resistance to entrance through their anterior wall. One skull presents a marked exception to this rule, the sinuses being surrounded on all sides by a thick layer of dense bone. (No. 5, Fig. 120.)

The variation in the posterior wall of the sinuses is of special interest. In 9 of the specimens a considerable thickness of cancellous bone would have to be removed before the hypophysis would be reached. Not only in these 9, but also in 15 others, the sphenoidal sinuses did not extend backward beneath even the anterior portion of the sella, and on this account its exact location would be very difficult to determine. (Nos. 4 and 7, Fig. 120.) So it appears that in 24 of those examined the sella turcica does not project into the sphenoidal sinuses. On the other hand, the backward extent of the sinuses may be such that a mere shell of bone lies between them and the cranial cavity. Thus in 37 of the skulls the bone was 2 mm. or less in thickness, and in 19 of this number the bone was translucent. (Nos. 8, 11, and 12, Fig. 120.)

Another complication which may arise is an unusual downward projection of the cribriform plate and adjoining superior surface of the sphenoid, so that in entering by a supranasal route the operator might pass completely beneath the sella turcica. This condition was marked in 4 of the skulls. (No. 12, Fig. 120.) He may also be in danger of passing beneath in those cases where it is unusually shallow, and has an abrupt backward slope instead of projecting markedly downward. (No. 11, Fig. 120.) Eight were of this type.

On the other hand, the surface of the sphenoid between the optic groove and the sella turcica, instead of continuing backward in the same general plan as the sphenoidal surface anterior to the optic groove, may project well-nigh vertically downward. This downward projection might easily be taken for the anterior margin of the sella turcica, in which case the optic chiasm rather than the hypophysis would be exposed. (No. 10, Fig. 120.) This condition exists in 6 of the specimens.

Irregularities of the sphenoidal septum add to the surgeon's difficulties. The sinuses are seldom of equal size and the septum often extends obliquely or in a few cases even transversely across the median plane. Such an irregular septum might be taken either for the floor or the roof of the sphenoid sinuses, according to its position and to the method of approach adopted by the surgeon, and the true posi-

tion of the hypophysis thus be obscured. (No. 9, Fig. 120.) Septa which were regarded as offering serious embarrassment to the operator were found in 2 skulls.

Nos. 1 and 2 in Fig. 120 illustrate skulls presenting favorable conditions for operation, or, in other words, not offering any of the peculiarities mentioned above. Thirty-four of this kind were found, or 32 per cent.

SUMMARY.

107 skulls examined.	Number.	Per cent.
Sphenoidal sinuses absent. (No. 3, Fig. 120.)	2	2
Sphenoidal sinuses small. (No. 4, Fig. 120.)	9	8.5
Compact bone surrounding sinuses. (No. 5, Fig. 120.)	1	1
Thick layer of bone between sinuses and sella. (No. 6, Fig. 120.)	9	8.5
No projection of sinuses beneath sella. (No. 7, Fig. 120.)	24	22
Large sphenoidal sinuses. (No. 8, Fig. 120.)	22	20.5
Thickness of posterior wall of sphenoidal sinuses 2 mm. or less. (No. 8, Fig. 120.)	37	34.5
Shallow sella turcica. (No. 11, Fig. 120.)	8	77.5
Downward projection of cribriform plate. (No. 12, Fig. 120.)	4	4
Optic chiasm especially endangered. (No. 10, Fig. 120.)	6	5.5
Irregular sphenoidal septum. (No. 9, Fig. 120.)	2	2
Skulls offering favorable conditions for approach to hydrophysis. (Nos. 1 and 2, Fig. 120.)	34	32
Distance from nasion to sella turcica varies between 56 and 68 mm. in	101	94
Distance from anterior nasal spine to sella turcica varies between 70 and 85 mm.[1] in	92	92

Treatment of the Tumor.—When the tumor is reached, if there is doubt as to whether the hypophyseal symptoms are due to tumor of the hypophysis or to a neighborhood tumor, a small piece may be removed for diagnosis. The anterior wall of the sella turcica having been meanwhile removed, much relief may be hoped for from the decompression. If the diagnosis is clear, as much of the tumor mass as possible should be removed; for although complete removal of the hypophysis is not compatible with life, it is probable that if a tumor be present we do not remove it all.

If a cyst be found, it should be opened and a strip of gauze packing inserted, after the walls are scraped as well as possible. The gauze helps to obliterate the cyst and also possibly aids in forming a fistula between this and the lining of the sinus so that it will not recur.

After-treatment.—The gauze packing should be removed from the nose as rapidly as possible after the danger of hemorrhage has passed. It is frequently advisable to aid free drainage by removing any blood-clots or collected mucus from the nose by swabs or washing and using an adrenalin spray in the nose. Those patients suffering from hypopituitarism should be fed upon the extract of the gland, and as our knowledge now stands it is better to use the whole gland. It should be used in large doses, regulated possibly by Cushing's sugar reaction. In our hands, however, this has not been a particularly adequate test.

Prognosis.—The prognosis as to life following the operation upon the hypophysis cannot be determined definitely. In the hands of the inexperienced the mortality will fall not far short of 40 per cent. In the hands of those who have had some experience, it is much less. Hirsch has operated upon 12 cases by his endonasal method, with 1

[1] This measurement made on only 100 skulls.

death; von Eiselsberg, upon 9 cases, with 2 deaths. One of us has operated upon 3 cases, with 1 death. Several cases are reported as dying from two to four weeks after the operation, of edema of the brain. Whether this was so, or whether the cause of death was an infection, is an open question. The Fröhlich type has given the best prognosis, not alone as to immediate, but also as to ultimate, result. Von Eiselsberg has reported 3 cases, with good results, 2 observed over three years. Personally one of us has such a patient who has remained well for over a year and a half. (See Figs. 121 and 122.) It is undoubtedly in this type that the most satisfactory results are to be found, although Halstead has operated upon an adenoma by his method with brilliant results. The patient has been free from all symptoms for over two years.

FIG. 121.—PHOTOGRAPH OF S. W., EIGHTEEN YEARS OF AGE. FRÖHLICH TYPE OF DISEASE. (Kanavel.)

Photograph one year after operation. Notice the height, the absence of hair on the body. The excessive adiposity which was present before the operation has disappeared.

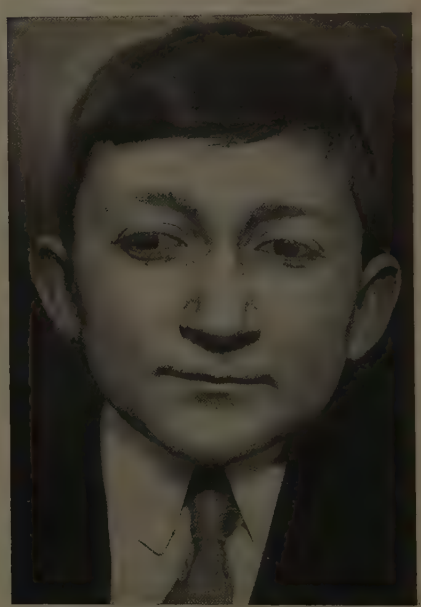

FIG. 122.—PHOTOGRAPH OF S. W., EIGHTEEN YEARS OF AGE. OPERATION, FEBRUARY, 1911. (Kanavel.)

Photograph taken one year after operation. Notice that scar under the nose is invisible.

The cases of acromegaly show a recession of the swelling of the soft parts at least and a cessation of growth of the bone (Figs. 123 and 124), although observations have not been made over a long enough time as yet to determine the absolute result. Two of Hochenegg's cases are classed as " good result " two years after operation.

Considerable improvement may be expected in the clinical blindness after operation. The part of the retina showing atrophy will not, of course, show any change.

The polyuria and glycosuria, if present, will also show improvement.

In the Fröhlich type the amount of growth that will follow operation and hypophyseal medication is problematic. In our case there has been a moderate growth of hair, but as yet no material change in the genitalia or the epiphysis of the bones. The excessive adiposis has disappeared. Here also the final reports must wait many years' observation.

FIG. 123.—FROM PHOTOGRAPH TAKEN TWO WEEKS AFTER OPERATION FOR ACROMEGALY. (Cushing.)
Shows situation of incision.

FIG. 124.—FROM PHOTOGRAPH TAKEN THREE MONTHS AFTER OPERATION FOR ACROMEGALY. (Cushing.)
Compare with Fig. 123.

We do not as yet know the ultimate results of the strictly decompression operations, whether done by the transphenoidal or intracranial routes. It is probable that such operations will be only temporarily palliative.

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CHAPTER CXI.

THE SURGERY OF THE NECK.[1]

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Chicago.

Anatomic Considerations.—Great emphasis is to be laid upon the compartments or cellular spaces of the neck. The easiest way to understand and memorize these is to get a clear mental picture of the *cervical fascia*. The simplest conception of this fascia is as of a tube divided by two vertical partitions into three cavities. The tube or envelope surrounds the muscles. The two dividing processes are:

(1) The prevertebral.

(2) The pretracheal.

The three cavities or compartments are formed between the two layers and extend from the head to the trunk.

(1) The vertebral compartment or "neck" proper (Fr., *Nuque;* Ger., *Nack*), containing the posterior muscles and spine.

(2) The middle or visceral compartment or throat (Fr., *Cou;* Ger., *Hals*), containing trachea, larynx, esophagus, thyroid, carotid sheath, and important nerves. This cavity is an open channel from the skull to the mediastinum and pericardium.

(3) The anterior compartment, like the posterior, contains chiefly muscles, sternomastoid, depressors of the thyroid, etc.

As already stated, these fibrous compartments have strong and inelastic walls which confine infections, pus collections, and even malignant tumors, so that they spread more easily within them than across them. It is vitally important to know their relations in operating for phlegmon of the neck, in dissection of glands, or removing cysts or growths.

Embryonal Cysts and Fistulæ.—A rare but interesting form of congenital cyst is a pneumatocele or air tumor of the neck. Brockaert, in a child one month old, found a rounded lateral tumor in the neck, which was resonant and disappeared on continued pressure. Upon placing the fingers over Rosenmüller's sinus in the pharynx the air could no longer be forced out. The sac was a persistent second branchial cleft or enlargement of Pitik's diverticulum.

An improvement in operating for branchial fistula is von Hacker's method of blunt dissection of the upper or deep part of the tract. This is the only difficult step. After a probe is inserted it is easy to excise a

[1] Supplementary to Chapter XXXVII., Vol. III., p. 277.

button of skin and platysma, and dissect it with a tube of the fistula back and up toward the hyoid bone and posterior surface of digastric muscles, then to free it by blunt dissection still intact. The sac should

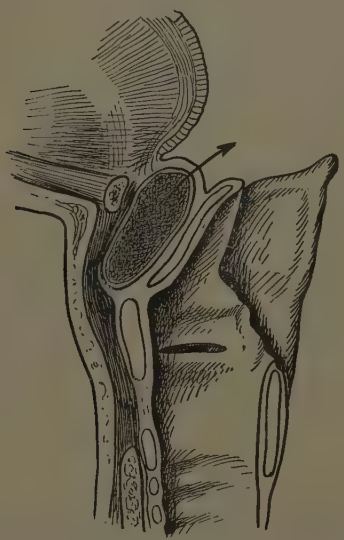

FIG. 125.—BRANCHIAL CYSTS PRESENTING BETWEEN TONGUE AND EPIGLOTTIS. (Doyen.)

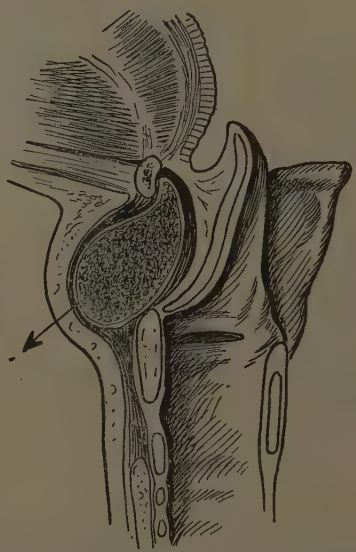

FIG. 126.—BRANCHIAL CYSTS PRESENTING TOWARD THYROHYOID MEMBRANE.

now be pushed or drawn into the pharynx through the pharyngeal opening, then ligated through the mouth and cut off. Thus, the removal is

FIG. 127.—CARCINOMA OF THE BRANCHIAL CLEFT, AFTERWARD REMOVED BY OPERATION. (Miles.)

complete and the orifice closed. Healing is prompt and no recurrences are reported.

Carcinoma of the branchial clefts is one of the commonest of the malignant tumors of the neck. That this type of epithelioma is of embryonal origin is evident from the fact that a small hard mass exists in some such cases from birth, which at middle life or later develops into a cancerous tumor. Like the mixed tumors of the parotid described (Vol. III., p. 326), it is not very malignant, and only slowly invades the glands or adjacent organs. This type of growth is more frequent in men than in women. Its location is usually the second branchial cleft, hence it appears as a hard swelling inside the sternomastoid at the side of the hyoid bone. Such tumors attain large size, and still are prone not to recur if radically removed.

Wounds and Injuries of the Neck.—It is becoming so well recognized as to be axiomatic that ligation of the common carotid for wounds or disease should never be practised when ligation of any other vessels, as the external carotid or internal jugular vein, can be substituted. While the temporary closure by Crile's clamp has no dangers, permanent ligation, according to recent statistics, carries a mortality of 50 per cent., as well as 49 per cent. of hemiplegia and other brain disturbances.

Ligation of the external carotid is both an easy and safe procedure, the mortality being from 1 to 4 per cent. As shown by Morestin, an excellent guide to this vessel is the posterior belly of the digastric muscle, making its location easy through a small incision.

Fig. 128.—Removal of Congenital Fistula by Everting Tract After Detaching Cutaneous Opening. (Doyen.)

Wounds of the veins may easily be stopped by light pressure, and time may be taken to prepare for an aseptic closure by suture of the walls of large veins without complete ligation. Picque described an interesting case of wound by a projectile. The embedded fragment caused no bleeding until efforts were made to extract it, when the internal jugular was found to be torn. The wound in this vessel was closed by lateral sutures and good recovery followed.

In wounds during operations the chief danger is from air embolism rather than bleeding; but both can readily be controlled by light tampons, and time taken for careful closure by suture rather than by deligation. However, complete ligation of the veins, as shown by Crile's cases, is far less dangerous than ligation of the common carotid.

Cervical Ribs.—Hunt reports another nerve disturbance beside those due to pressure on the cervical plexus, viz., spasm of the diaphragm due to a cervical rib. The usual remedies gave no relief, and the rib was removed to relieve possible pressure on the phrenic nerve. A complete cure was obtained.

The symptoms due to nerve pressure may appear as early as puberty. In 4 out of 6 reported by Sawyer the patients' work required much hand-and-finger movements, suggesting that some occupations may develop the trouble more than others. In 1 out of 6 cases only were the blood-vessels interfered with. Plummer, in 2 cases of operation for cervical rib, had good results in 1, but reports partial failure or great

FIG. 129.—LOCATIONS OF DEEP AND SUPERFICIAL ABSCESS OF THE NECK.
1, Spondylitis with perforation of esophagus; 2, subaponeurotic abscess; 3, superficial abscess; 4, deep cervical glands; 5, deep posterior tuberculous abscess.

delay in restoring nerve function in the other. The increasing number of cases now being reported confirm the old observation that most cervical ribs are often bilateral, but that only one causes trouble. Francine reports a case in which a cervical rib had a distinct articulation at about its middle. This was confirmed by skiagram and by operation.

Suppurative Processes in the Neck.—Suprahyoidean infections give rise to abscesses which burrow deeply in the neck if neglected, but at first they appear more pronounced in the mouth and pharynx. The patient presents a swelling beneath the tongue and

the whole floor of the mouth is indurated. This induration and swelling also extends below the jaw into the neck. The onset is severe, with high temperature and great pain. Incision through the floor of the mouth is less advisable in these cases than free dissection externally. As shown by Lejars, this gives good drainage and brings about rapid healing if done early. The rôle of foreign bodies in causing deep abscesses of the neck cannot be ignored. Numerous cases are reported in recent journals by Sternberg, Marx, Ruttins, and others, in which perforation of the esophagus by hard objects swallowed or by penetrating wounds from without gave rise to dangerous abscesses.

Thoracic Duct.—As mentioned in Vol. III., p. 316, Quain, Wendel, and others have found the outlet of the thoracic duct double or delta-

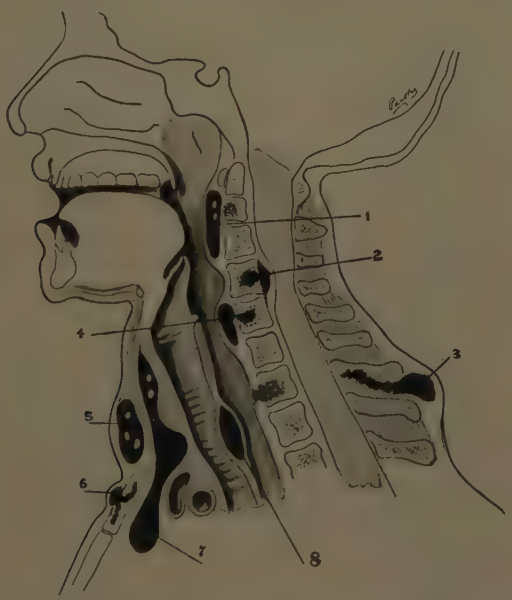

FIG. 130.—LOCATION OF DEEP PHLEGMON OF THE NECK. (Doyen.)
1, 2, 3, 4, Retropharyngeal and vertebral abscesses; 5, superficial abscess; 6, abscess of manubrium; 7, deep suppuration descending into chest; 8, abscess between trachea and esophagus due to perforations.

formed in many cases. This explains why the injury of one branch does no serious harm if it be ligated. Recently, Parsons and Sargent have made dissections of 40 subjects carefully injected. In almost half the number (18 out of 40) the duct had two branches—half, or 9, of these had the branches reunited. Seven had two insertions into the vein. Two cases had four insertions. Verneuil found the duct branched in 6 out of 24 cases. Wendel, in 8 out of 17 cases. As there are often also anastomoses with the azygos vein deep in the chest, or with a duct on the right side, it is easy to see why simple ligation of the duct when it has been wounded has been followed by so many cures. Fredet reports 58 cases collected from the literature, with 5 deaths. Van Bockstaele tied the duct, which he had severed in operating for

a large sarcoma, but had a fistula after two days. This refused to close on cauterizing with chlorid of zinc, but healing and rapid recovery followed injection of a strong solution of antipyrin. Garrè also reports a case of fistula which was cured by cutting down and removing an infected ligature on the duct.

Chylous fistulæ in some cases discharge an enormous volume of fluid, either externally or into some cavity, as the abdomen or pleura, or externally through a wound. By a novel procedure Morgan, of Chicago, had a remarkable cure of an enormous chylous ascites due to wound of the duct. This consisted in a course of rectal feeding, all food being withheld from the stomach. After a few days all outpouring of chyle ceased and rapid recovery followed.

Tumors of the Neck.—Recent views of the relation of Hodgkin's disease and sarcoma are in the direction of classing the former as malignant.

FIG. 131.—BLUNT DISSECTION WITH MAYO SCISSORS ENUCLEATING LYMPH-NODES FROM CAPSULE.

Primrose thinks the view that Hodgkin's disease develops malignancy is gaining ground, and reports several cases to prove this. Ehrlich, Loeb, and Coley have reported transformations or else metastases of carcinoma into sarcoma, both in animals and man. Yamaski and also Banti believe that in certain cases Hodgkin's disease may become sarcomatous. It is to be noted that sarcoma of the neck often occurs in youth or childhood. Out of 10 cases reported by Primrose, 3 patients were young —viz., 1 a little child, 1 aged twenty, and 1 aged twenty-seven. The progress of sarcoma is most rapid along fascial and fibrous structures, destroying the sternomastoid and other muscles and sometimes the great vessels, but only pushing aside the trachea and esophagus, without invading their cavities.

Operative Technic in Operations in the Neck.—Recent practice has tended to confirm the value of Kocher's horizontal or "normal" incisions not only in goiter, but in all operations in the neck, as for glands, abscesses, etc. These incisions follow what may be termed the natural cleavage of the skin, so as to avoid cutting nerve-fibers, and are usually circular or collar-like in direction. (1) In the upper lateral triangle of the neck the "normal" incision is about 2 cm. below the jaw, and extends from the mastoid process to the hyoid bone. Thus, it runs along

the line of meeting of the upper muscles, digastric, stylohyoid, geniohyoid, etc., with the lower omohyoid, sternohyoid, etc. No important nerves or muscles cross this line. It exposes a large field containing the bifurcation of the two great vessels, branches of the external carotid and important nerves, the vagus, facial, hypoglossal, spinal accessory, descendens noni, and the deep viscera. (2) In the lower lateral triangle of the neck the "normal" incision is also horizontal or nearly so. It extends from the inner end of the clavicle outward and slightly upward

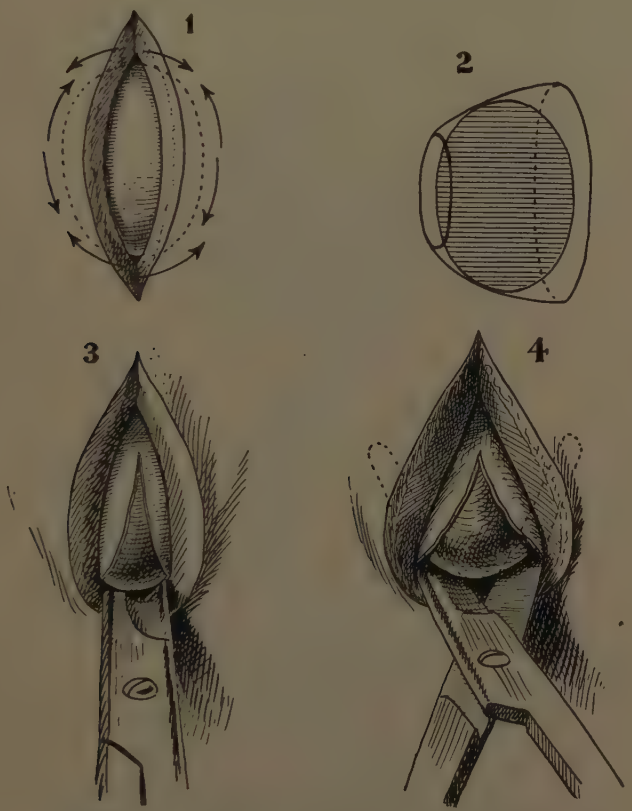

FIG. 132.—DOYEN'S METHOD OF ENUCLEATION WITH SCISSORS.
1, Diagram of action of scissors in blunt dissection; 2, same viewed transversely; 3, scissors' point behind gland; 4, divulsion by spreading blades of blunt scissors.

to the trapezius. This exposes the inferior lateral triangle adequately. It will be seen that it follows the line of Dowd's incision, rather than the older plan of dividing vertically behind the sternomastoid muscle. Operators who have practised only the vertical incisions for these operations are at first skeptical of the value of the collar or Kocher incisions, but it may be said that they are found to give ample room for entering all the compartments of the deep fascia. The lower lateral triangle exposed by this incision is formed by the clavicle, the sternomastoid,

and the trapezius. Its deep floor contains the first rib, pleura, and great vessels, as well as lymphatic chains and the thoracic duct. (See Fig. 135.)

FIG. 133.—MUSCULOCUTANEOUS FLAP AS ADVISED BY QUERVAIN.

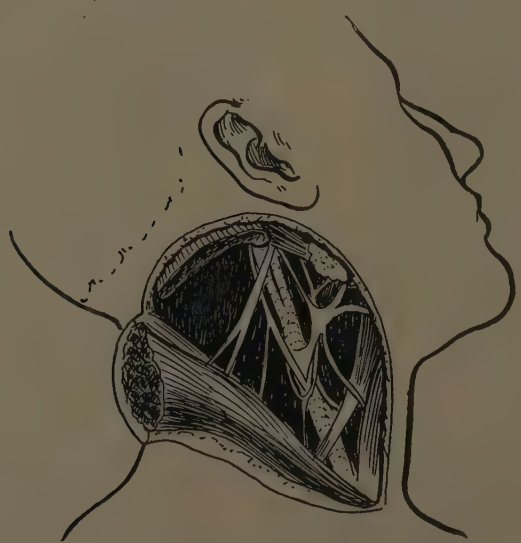

FIG. 134.—MUSCULOCUTANEOUS FLAP OF KÜTTNER.

Another important improvement in the technic of gaining access to the deep structures of the neck is seen in the methods of Quervain and

Küttner, of dividing and raising the sternomastoid muscle with the skin flap. As mentioned in Vol. III., p. 330, this muscle was partly raised by Fenger after dividing the clavicular attachment. Crile also advocated its complete removal in malignant cases. It remained for Quervain to devise a flap of skin and muscle by dividing the sternomastoid near its lower end and reflecting it with the skin flap. Küttner makes a similar skin-and-muscle flap by dividing this muscle close to the mastoid process. In both methods the spinal accessory nerve is avoided and no paralysis

FIG. 135.—CONTENTS OF INFERIOR LATERAL TRIANGLE OF THE NECK.

or atrophy results. These methods may well take the place of more tedious dissections for glands or malignant growths, which usually required extensive undermining of the skin, so as to mobilize this muscle on both sides, or else a splitting of its fibers. Experience showed that much time was lost in identifying and saving the spinal accessory nerve, and its occasional division caused paralysis of the trapezius muscle. For many operations, as on the vessels alone, especially in the middle part of the neck, ample room can be secured without dividing this muscle. Even the deepest visceral compartments of the neck can easily

be explored by the collar incisions. Thus, the space between the trachea and the esophagus, or between the esophagus and the spine, is readily entered for the removal of glands, collections of pus, etc. The deep jugular is amply exposed, and can be still more extensively laid bare by division of the omohyoid.

Doubtless our experience with the "normal" incision for goiter operations has led us to see its wide usefulness in all explorations on the neck cavities.

Surgery of the Thymus Gland.—Much has been added recently to our knowledge of the pathology and surgical treatment of the thymus. Veau and Olivier report 3 successful operations in children of eleven, thirteen, and twenty-two months by total subscapular thymectomy. These were all for grave suffocative crises and resulted in complete cures. In 19 cases gathered from the literature the following facts are emphasized: While sudden death, or "thymustod," will still be met in the absence of a physician, it is probably rare that a case does not show warning signs earlier—the so-called "minor signs of hypertrophy." In other words, the sudden death is not the only clinical symptom, but is preceded by functional symptoms and positive physical signs. These may be classified as (1) the usual or common signs of thymic hypertrophy, viz., stridor, permanent dyspnea, and suffocative crises; and (2) the atypic or unusual symptoms, viz., dysphagia, vascular pressure, and eczema. These are all due to one pathologic factor, the compression of the viscera, especially the trachea, by the bulk of the thymus crowding between the manubrium and the air-passages. *Stridor*, if congenital, is practically always "thymic stridor." Even if changes are found in the larynx and trachea they are secondary to the pressure, according to the views of some pediatrists. Consequently, operation has been practised by Jackson, König, Hinrichs, McClennan, Schwinn, and perhaps others, with numerous cures. It is but fair to state, however, that Variot, Van Bokay, and others deny this, and believe congenital stridor is due to inflammations not due to outside pressure. They cite cases in which thymectomy failed to give relief. These differences of opinion lead us to recognize two possible forms of stridor, a laryngeal and a thymic, the latter only being suitable for operation. *Permanent dyspnea* is a more reliable sign of thymic pressure, especially if there be a tugging respiration which is constant. All the reported operations based upon this sign are regarded as cures, indicating that it is a more reliable symptom than stridor.

Suffocative crises, the most positive of all signs, is not now thought to be universally fatal. Medicolegal experts and physicians will still see many cases only after death, but it must be admitted that minor crises are met, with or without a previous stridor or tugging respiration, cases of dyspnea and cyanosis which passed away. They are an absolute indication for operation. Tracheotomy and intubation are of no value. Total ablation of the thymus has resulted in complete relief in numerous cases. Of the less constant symptoms, *dysphagia* is readily explained by the pressure of the gland. Hinrichs has performed thymectomy for

this condition with complete relief. *Venous pressure* is believed by Murphy to lead to edema of the organs in the neck, and to be a possible indication for thymectomy, but as yet no operations have been reported for this indication alone.

Eczema in infants has often been noted as present in cases of thymus death. It is of a dry form, due, according to Lesage, to thymic dyscrasia or status lymphaticus. On theoretic grounds he thinks the time has come for applying thymectomy to some of these cases, as medical management is usually ineffective.

Of late, several new points in the symptomatology are being brought out. Mery found that the chest walls collapsed or were molded inward slightly on hard expiration in a child five months of age, causing the sternum and adjacent ribs to be prominent over the tumor. Barbier also reports this sign as a "vaulting of the manubrium." Olivier denies that this is common, as does Lenormant. Palpation, radiography, and percussion are of great value in assisting to make the diagnosis. It must be remembered that the largest thymus is not always the one which causes the most trouble. Cases of death from quite small ones are reported, and glands of large size are seen without dangerous complications.

The area of thymic dulness can be marked out by percussion. It is triangular, with the apex downward below the second rib, and the base on a level with the top of the sternum. A resonant space separates it from the cardiac dulness. Radiography and radioscopy are difficult in young children, but usually give positive results. Hochsinger reports 58 cases, all showing a clear outline of the gland.

Operative Technic.—The simplest interference possible is the exothymopexy of Rehn. Some cures by this method are beyond dispute, yet Veau and Olivier condemn it on the ground of being more difficult than extirpation. The fixation is effected by suturing the gland to the top of the sternum, which, as it involves enucleating it from its fossa, seems more complicated than tying off the small pedicle. No evil results are known to follow ablation. Resection of the manubrium to gain access to the gland has been practised by König and F. G. Murphy. This is classed by J. B. Murphy as "a very useless complication of thymectomy."

It should be remembered that thymectomy by simple ablation has shown almost no mortality. The gland should be lifted from its bed by gentle traction and a subcapsular enucleation made. This is the natural and easy line of cleavage. No attention need be paid to the adjacent viscera, as the subcapsular dissection avoids them. Sometimes the respiratory efforts push and almost deliver the gland upward, assisting the enucleation. No advantage can attend extracapsular ablation or partial thymectomy, unless it can be shown that some harm results from its loss. The incision should be vertical, ending a little below the top of the sternum. After dividing the deep fascia, the sternomastoid muscles are prominent landmarks. These can be retracted, and the sternothyroids usually can be separated without cutting their fibers.

The cellular space now opened contains the trachea, and the thymus appears just behind the sternum, rising with each inspiration. It is grayish, round, and very movable on pressure. The capsule is a fibrous sheath, which can now be opened and access gained to the gland, which is readily loosened by a smooth director or the finger. The left lobe is usually seized first and can almost be lifted out without bleeding. After this many operators prefer to lift out the other lobe, while a few advocate ligating through its substance, leaving part, as in thyroidectomy. Unlike the thyroid, the thymus has very few vascular branches from its capsule. It does not bleed much when withdrawn, and the pedicle could often be left without ligation, but it is advised to tie it in all cases as a precaution. The large cavity left by removing the gland cannot be closed, but the fascia must be closed by buried stitches before uniting the skin.

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CHAPTER CXII.

DISEASES OF THE THYROID GLAND.[1]

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The thyroid, the most accessible of the ductless glands, is no longer conspicuous for either the rarity of operations upon it or the high mortality following operations. The brief space allotted to the subject in this supplementary volume makes it necessary to refer the reader for a general description of the anatomy, physiology, pathology, treatment, etc., to the exhaustive article on the subject by Albert Kocher, in Vol. III., p. 336. Only those points which are directly related to the surgery of the gland will be discussed in this chapter.

Embryology.—The thyroid gland begins as an evagination of the epithelium of the alimentary canal. The first bud is found in 4-mm. embryos in the median line of the front of the pharynx at the base of the tongue. The pocket, which is at first tubular, early becomes a lumenless cordon, and rapidly enlarges transversely, in its distal portion becoming in 16-mm. embryos an anchor-shaped mass of epithelium with but a shallow pit, later the foramen cecum marking its point of origin on the tongue. The fact of greatest interest to the surgeon in connection with the development of the thyroid is that the primitive lumen of this median bud sometimes persists even in the adult as the thyroglossal duct. Sometimes the "stem of the anchor" is but intermittently obliterated, the islets of thyroid tissue developing into a chain of "median accessory thyroids," while its lower end forms the pyramidal lobe. While the bulk of the thyroid is formed from the median anlage, there are, in addition, two lateral analgen which appear as evaginations of the epithelium of the fourth pharyngeal groove in 10-mm. embryos. These lateral analgen form lumenless cordons which gradually fuse with the lateral masses from the median anlage in embryos of about 20 mm., and thus assist somewhat in the formation of the lateral lobes of the thyroid. In 60- to 70-mm. embryos the epithelium gradually becomes arranged in spheroidal groups, which later show more or less well-defined lumina. Within these secretion is present as early as the fifth month of fetal life.

Anatomy.—It should be noted that the inner surface of the gland is transversely concave, enwrapping the trachea and larynx, while the antero-external surface, meeting the inner at a sharp posterior border, is convex in all its diameters, and lies immediately under the middle layer of the cervical fascia, which is covered by the infrahyoid muscles.

[1] Supplementary to Chapter XXXVIII., Vol. III., p. 336.

The posterior surface is in apposition with the sheath of the carotid artery. Occasionally the carotid is external to instead of posterior to the gland, though always in close relation thereto. The internal jugular veins, lying slightly anterior and lateral to the common carotids, are sometimes in immediate contact with the lateral lobes of the thyroid. The blood-supply is from a pair of inferior thyroid arteries which enter the lobes from the inner surface, and a pair of superior arteries which enter from the antero-external surface. The anastomoses between these two pairs of vessels are very free. The left inferior laryngeal nerve always lies in direct contact with the inner surface of the thyroid, and the right one frequently so. The gland is firmly attached to the neighboring structures by its fibrous sheath, two median bands of which, passing to the hyoid and cricoid cartilages, act as suspensory ligaments.

Histology.—The thyroid gland is a compound alveolar structure without an excretory duct. Septa from the capsule of the gland divide the organ into well-defined lobules, which are, in turn, divided into primary lobules from ½ to 1 mm. in diameter, which are composed of terminal follicles corresponding to the acini of other alveolar glands. The acini, which are from .05 to 0.2 mm. in diameter, vary in size according to their content. Their epithelium is ordinarily a single layer of cuboidal cells. Where the epithelium is hypertrophied these cells become columnar in type. Where it is atrophied, with distention of the acini, they become markedly flattened. The cells rest, without the intervention of a basement membrane, directly on a layer of connective tissue surrounding the blood- and lymph-vessels.

Pathology.—The abnormal changes in the thyroid gland may be outlined in the following classification, as proposed by Louis B. Wilson:

I. Embryonic (undeveloped) thyroid.
II. Normal (resting) thyroid.
III. Vascular changes.
    1. Hyperemia.
    2. Hemorrhage (including resulting cyst formation).
IV. Inflammations.
V. Progressive changes.
    1. Hypertrophy (functional, with hyperemia).
    2. Hyperplasia (" exophthalmic " goiter).
    3. Adenomatosis (multiplication of acini without encapsulation).
VI. Retrogressive changes.
    1. Retention of secretion (colloid goiter).
    2. Atrophy (of parenchyma).
    3. Degenerations.
        (*a*) Colloid (of parenchyma and stroma).
        (*b*) Hyalin.
        (*c*) Amyloid.
        (*d*) Calcareous.
        (*e*) Cyst.

VII. Tumors.

1. Benign.
   (*a*) Fetal adenomata (encapsulated).
   (*b*) Adult adenomata (encapsulated).
2. Malignant.
   (*a*) Mesotheliomata.
   (*b*) Carcinomata.
   (*c*) Sarcomata.

I. *Embryonic* (*undeveloped*) *thyroid* is occasionally met with in the cretin, though the gland here more usually shows retrogressive changes. Microscopically, the tissue consists of diffuse embryonic parenchyma (Wölfler's islands) with more developed embryonic acini, most of which are lumenless.

II. *Normal* (*resting*) *thyroid* is a difficult stage to define, since the gland varies so greatly within physiologic limits. It seems best, however, to take as a basis of normal histology that picture of the gland in which its parenchyma is resting, that is, in which there is no sexual or other functional, periodic, or incidental excitement. Histologically, the gland under these conditions consists of spheroidal acini with well-developed central cavities lined with a single layer of cuboidal epithelium. While the character and amount of secretion vary greatly, in the young, where preceding inflammations and progressive changes have been few, the stainability (*i. e.*, density) of the colloid is very low and its osmotic index high.

III. 1. *Hyperemia* in the thyroid is quickly brought about by excitement (sexual, fear, etc.) and is usually fleeting. Hyperemia, however fleeting, materially increases the index of excretion of the gland.

2. *Hemorrhage* may be so extensive as to cause sudden and great enlargement of the gland, and frequently results in secondary cyst formation.

IV. Acute *inflammation* of the thyroid is usually a result of traumatism or an incident in the course of general bacterial diseases (puerperal septicemia, pneumonia, endocarditis, miliary tuberculosis, etc.). A moderate grade of chronic inflammation of the stroma is the usual accompaniment of marked retrogressive changes.

V. 1. *Hypertrophy* of the parenchyma of the thyroid quickly (within a few hours) follows hyperemia, and is almost invariably associated with the latter. The parenchyma cells are swollen, columnar, and are apparently actively functionating. The acini are dilated and the secretion has a relatively low density. Such hypertrophies usually result in secretion and excretion within physiologic, though temporarily excessive, limits.

2. *Progressive hyperplasia* of the thyroid has almost invariably associated with it parenchymatous hypertrophy. In addition, however, to the hypertrophic changes, there is an increased number of parenchyma cells either in the original single or in multiple new layers. Accompanying this is an overgrowth or stretching of the stroma or an infolding of

the walls of the acini, with papilliferous outgrowths into their cavities, to provide attachment for the increased parenchyma. Early, the secretion has a low density, which rises as the overfunction is prolonged. This condition is *par excellence* that associated with progressive toxic symptoms of exophthalmic goiter.

3. *Adenomatosis* of the thyroid consists of a diffuse multiplication of the acini from either undeveloped embryonic acini or Wölfler's rests. Such a diffuse increase in the number of acini should be sharply distinguished from the formation of encapsulated adenomata. Adenomatosis may be associated with hypertrophy or hyperplasia of the contained parenchyma, and thus be present in grave exophthalmic goiter. Sometimes, however, the parenchyma remains cuboidal and without marked hyperplasia. Under these circumstances the condition is associated with slowly developing symptoms of thyrotoxicosis.

VI. Of the *retrogressive* changes in the thyroid, (1) *retention of secretion* is the most common. While the thyroid gland is an actively secreting organ, its excretory mechanism is weak and readily obstructed either by changes in the lymphovascular system or in the density of the secretion as it comes from the parenchyma. Any such blocking of excretion results in the storing-up within the acini of the less absorbable contents of the secretion. There thus results more or less distention of the follicles by the so-called " colloid " material of markedly increased density and lowered osmotic index. It is futile to discuss whether this storage of so-called colloid is " normal " or not, since the degrees of distention of the follicles and of density of secretion are so variable. It would seem, however, that the secretion should be considered in the same light as small retention cysts in obstructed acini of mammæ that have lactated, with this difference, that the dense colloid may be so changed by later hyperemia or hyperplasia as to permit its absorption after long quiescence. Retention of secretion is the essential element in the formation of the so-called " colloid " or " simple " goiters.

2. *Atrophy* of the parenchyma results, as elsewhere in the body, from overwork and pressure. It may be a direct change from hyperplasia, though it more usually results after the intervention of retention of secretion. The cells become flattened and may even necrose and desquamate.

3. Of the *degenerations*, (*a*) *colloid* is most frequent, though often overlooked in both the parenchyma and stroma. It has apparently been mistaken by some observers for colloid within the vessels. (*b*) Hyalin degeneration is not unusual; (*c*) amyloid is less frequent; (*d*) calcareous degeneration is very common, and (*e*) cystic degeneration often results from the breaking down of interacinar walls.

VII. Of the *tumors* of the thyroid we should recognize as *true adenomata* only those which are encapsulated. These are histologically of two types: (*a*) fetal adenomata, in which the parenchyma is recognizably of true fetal type, *i. e.*, consisting either of cordons, embryonic tubules, or more or less lumenless spheroidal cell groups, or of combinations of these group units. (*b*) Adult adenomata are encapsulated

tumors in which the parenchyma has taken on adult characteristics, that is, it consists largely of spheroidal follicles containing lumina, lined with cells of adult type. The tissue of adult adenomata may take on all the changes which have been noted in the thyroid gland tissue outside encapsulated tumors. While it may be true that adult adenomata do develop from fetal rests, there is insufficient evidence to demonstrate this beyond peradventure, and for both pathologic and clinical purposes it is best sharply to differentiate the two on the lines above indicated.

Concerning the *malignant* tumors of the thyroid there has been considerable confusion, especially in the differentiation of the various types of so-called carcinomata. No doubt many of the tumors which have been hitherto described as carcinomata are really (*a*) mesotheliomata or mixed tumors of embryonic origin. True (*b*) carcinomata, however, not infrequently occur, usually in glands which have long been the site of retrogressive changes. Their types vary in accordance with the pressure from formation of stroma, and with the tendency to revert to embryonic type.

(*c*) *Sarcomata* we have found to be very rare, and we are inclined to think that many of the tumors reported as sarcomata are really mesotheliomata (mixed tumors).

GOITER, CLINICAL DESCRIPTION.

(Henry S. Plummer.)

Types.—The *hyperplastic goiter* is regular in outline, usually hard, and conforms to the shape of the normal thyroid. The right lobe is, as a rule, a little larger than the left. A thrill or bruit may be noted over one or more of the thyroid arteries in 75 per cent. of the cases.

The *colloid goiter* is, as a rule, regular in outline, relatively soft, and when small conforms to the shape of the normal thyroid. As it enlarges the lobes may become unequally involved.

Adenomata are palpable, spheroidal, tumor-like masses, either single or multiple. Cysts, calcareous deposits, fibroid changes, the degree of distention, and combinations of the various types, all vary the shape and the density of the mass.

Symptoms of Pressure.—These symptoms may be classified as follows:

(1) Evidences of a damaged *heart* are present in about 20 per cent. of the cases coming to operation for simple goiter. It is, however, impossible accurately to determine the relative parts played by mechanical obstruction and thyrotoxicosis in the production of the heart symptoms. Pressure on the trachea, bronchi, and arterial trunks of the superior thoracic strait has seemed to be a definite factor causing cardiac insufficiency in 6 per cent. of the cases of simple goiter thus affected. Most of these patients have substernal goiter.

(2) Marked dyspnea and, not rarely, sudden death result from flattening, narrowing, or kinking of the trachea. Changes in the mucous mem-

brane of the trachea, larynx, and bronchi, with resulting cough and dyspnea, also are not uncommon.

(3) Paralysis or paresis of one or both vocal chords is present in 19 per cent. of cases of goiter. Paralysis of one nerve may be present without marked dysphonia. Sweating, hyperemia of the face, and alterations in the pupils are occasionally noted from pressure on the sympathetic. Even the spinal accessory may be involved in very large goiters.

(4) Mild dysphagia from pressure on the esophagus is frequently noted, but very rarely becomes distressing.

(5) Pressure on the blood-vessels may cause congestion and even edema of the face. Dilatation of the veins of the upper chest is frequently associated with goiters crowding down into the superior thoracic strait.

FIG. 136.—CASE 23,448, AGED THIRTY-SIX YEARS. EXOPHTHALMIC GOITER, SHOWING SEVERE SYMPTOMS.

Symptoms of Thyrotoxicosis.—Hyperplasia of the thyroid is accompanied by a definite train of symptoms, known as Graves' disease, Basedow's disease, exophthalmic goiter, etc. *The clinical picture early in the history of Graves' disease is that of a toxin acting directly on the more vital organs, most notably the central nervous and vascular systems.* Later, it is made more complex by the interaction of those organs whose functions have been directly disturbed by the toxin.

The order of onset of the most important symptoms, based on the average of a large series of cases, is as follows: (1) Mental irritability, (2) tachycardia, (3) vasomotor disturbances of the skin, (4) tremor, (5) muscular weakness, (6) loss of weight, (7) exophthalmos, (8) diarrhea, and (9) vomiting. If the average course of the disease be represented by a curve, the greatest height of the intoxication is found to be reached during the latter half of the first year, and then rapidly drops to the twelfth month. In many instances it reaches the normal base-line during the next six months, more often it fluctuates with periods of exacerbation for the next two to four years. Secondary symptoms and exophthalmos may remain, but the active course rarely continues over four years without distinct intermissions. The ascent may be gradual, sudden, or irregularly marked by many secondary curves.

After the first year the symptoms from a damaged heart, liver, kidneys, etc., enter more strikingly into the clinical picture, and, with even lesser degrees of intoxication from the thyroid, may give rise to disability and frequently to death.

The operative mortality in exophthalmic goiter has been materially

reduced by avoiding the periods of exacerbation. Mental irritability, loss of weight, muscular weakness, vomiting, and diarrhea are the symptoms that most strikingly mark the periods of maximum intoxication. Mental irritability is one of the most constant symptoms of exophthalmic goiter and the most important single indication of the degree of intoxication, and hence of the immediate grave prognosis, both medical and surgical. It appears early in the history and is frequently a valuable warning, preceding dilatation of the heart, vomiting, and diarrhea.

The degree of damage to the heart follows the general curve of the other symptoms of the disease. While dilatation of the heart is always to be viewed with serious concern in determining the operative prognosis, it is much more to be feared when associated with a high degree of mental irritability. Other things being equal, a primary dilatation of the heart which, as in the average curve, occurs at the ninth month, should cause

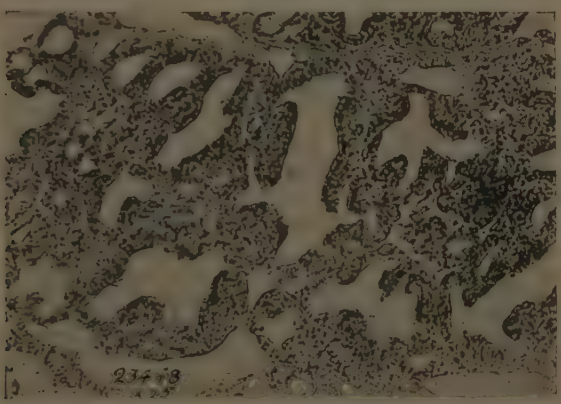

FIG. 137.—CASE 23,448. MICROSCOPIC SECTION OF GLAND REMOVED FROM CASE SHOWN IN FIG. 136. Shows increased alveolar parenchyma, papillæ formation, and enlargement of non-staining secretion.

more serious concern than that appearing later as a result of long-continued intoxication and overwork. Diarrhea and vomiting may occasionally occur in relatively mild cases, though, as a rule, these symptoms mark a period of intoxication but little short of that necessary to cause the death of the patient. Marked mental irritability, however, especially if associated with mental depression without loss of weight, muscular weakness, or dilatation of the heart, should be looked upon as an indication of a high degree of intoxication. We have been unable to confirm the views of other observers of the prognostic value of the white blood-count.

Twenty per cent. of the cases of *simple goiter* coming to operation also show some definite evidences of intoxication, but in patients with simple goiter the average lapse of time between the appearance of the goiter and the thyrotoxic symptoms is fourteen and one-half years. The onset is usually insidious. Kocher believes that the prolonged use of iodin is a frequent cause of the development of this condition.

Cardiac insufficiency (heart of toxic goiter) dominates the well-developed clinical picture, which in many instances cannot be easily differentiated from that due to a heart injured from other causes. Nervousness, tremor, and loss of strength and weight may appear long before definite evidence of myocardial change. In some cases the clinical aspect closely approaches that of exophthalmic goiter. The symptoms, however, are less complex, less intense, and less definitely associated. While Stellwag's[1] symptom is noted in 5 per cent. of the cases, exophthalmos is rarely, if ever, present. The development of a typical syndrome of Graves' disease in a case having a definite history of simple goiter means that a hyperplastic goiter has been superimposed upon the simple type. In a small percentage of mild or atypical cases the final differential diagnosis must sometimes rest on the microscopic examination of the gland. The evidences of a heart lesion being the same, the operative risk is materially greater in cases having secondary hyperplasia than in cases of simple goiter without it.

Indications for Operation.—These may be classified as follows: (1) Cosmetic; (2) relief of pressure; (3) relief of thyrotoxicosis; (4) prophylaxis for the preceding indications. An operation for cosmetic purposes alone is rarely indicated. Symptoms due to pressure sufficient to call for operation occur most frequently with adenomatous goiter. Colloid goiters do not often cause severe symptoms by pressure until they reach a relatively large size, while it is extremely rare for hyperplastic goiters to produce sufficient evidence of pressure to indicate operative measures.

Operation is always indicated in cases of simple goiter having thyrotoxic symptoms, provided the condition of the patient warrants it.

Thyroidectomy and ligation for exophthalmic goiter are based on a fairly well-established theory that the symptoms are due to an excessive secretion of an abnormal thyroid which is proportionate to the extent of the hyperplasia. In choosing a time for operation the periods of exacerbation should be avoided. Operation is, in general, indicated in all cases that come under observation while the thyroid is elaborating secretion in excess of the demands of the individual. The relative value of thyroidectomy and ligation has not been as yet definitely determined. Ligation seems, at least, temporarily to diminish the activity of the thyroid, and its field is recognized as being preliminary to thyroidectomy.

The fact that adenomata seldom, if ever, disappear spontaneously, and that at least 25 per cent. ultimately produce well-defined symptoms of pressure or thyrotoxicosis, makes their removal desirable as a prophylactic measure in all cases in which the general state of the patient permits and unless other conditions unassociated with goiter contraindicate it. Large colloid goiters should, as a rule, be removed, but at just what point the line should be drawn in operating upon small, diffuse,

[1] *Stellwag's Sign.*—Staring without winking for long periods.

Dalrymple's Sign.—Widening of the palpebral fissure, showing excessive surface of sclera around the cornea.

Graefe's Sign.—Lagging behind of the lids, which move by slight jumps after the movement of the eyeball.

colloid enlargements unaccompanied by symptoms of thyrotoxicosis or pressure is less clearly indicated, and must be left to the judgment of the individual surgeon.

SURGERY.

Preparation of Patient.—While great care is essential in operating upon goiter, especially the extreme types of exophthalmic goiter, it is undoubtedly true that the reduction in mortality has come from the better judgment of both physician and surgeon in the selection of cases, from careful consideration of the stage of the disease, and from preparation of the patient for operation in complications of ascites, nephritis, diabetes, and myocardial disturbance, rather than from any great improvement in surgical technic.

Operating-table, Instruments, Etc.—Surgery of the neck, and of goiter in particular, may be classed as special surgery. To insure proper technic the details as regards table, instruments, assistants, etc., should be carefully carried out.

(1) The table should pivot from the center, so that the body may be inclined head up, yet it must be capable of giving the reverse position quickly. It should also have an adjustable head contrivance, permitting the head to be thrown back, thus advancing the thyroid and enlarging the operative field. A wire frame should encircle the head of the table. Over this should be drawn a sterile cover notched in the center to fit tightly across the patient's neck, close beneath the chin, forming a shield to protect the wound against the breath and secretions of the mouth, and also to effectually separate the anesthetist from the field of work.

(2) Special instruments are not required, but can be used at the preference of the operator. Several dozens of forceps should be at hand. We prefer the 7-inch Kocher artery forceps for most purposes. A fine round-pointed Kelly forceps is useful for blunt dissection and handy for catching or dissecting fine vessels. A pair of 7-inch round-pointed dissecting scissors are useful instruments for quick blunt dissection. Other instruments, such as tractors (blunt and sharp) and knives are required as for ordinary operations. The Kocher gland clamp, the Kocher gland forceps, a blunt dissector, and a spoon may be convenient. In substernal goiter cases it is convenient to have at hand both a desert- and a tablespoon. They are often useful in elevating substernal tumors. Catgut is a satisfactory ligature material.

(3) Two well-trained assistants are necessary, as well as a nurse for the supply table.

Anesthetic.—In operating upon all forms of simple goiter and most exophthalmic goiters, general anesthesia is as safe and practical as for other general surgery, and we believe it is indicated in most cases of thyroidectomy. We prefer the open drop method with ether, but not to the stage of profound anesthesia. Local anesthesia—cocain or novocain with adrenalin—is also of practical value and gives satisfactory results. Most cases of complicated goiter and of ligation—those with heart

disease, nephritis, tracheal pressure, or other conditions that render a general anesthetic unsafe—are best operated on by this method. In exophthalmic goiter, if the condition be at all serious, the patient is given scopolamin $\frac{1}{200}$ to $\frac{1}{150}$ gr. hypodermically one hour before operation. All patients with simple goiter who are to take a general anesthetic are given morphin $\frac{1}{6}$ gr. and atropin $\frac{1}{120}$ gr. hypodermically thirty minutes before operation.

In some excitable, nervous individuals with exophthalmic goiter the Crile[1] anoci-association preparation can be used to advantage. The technic is substantially as follows: (1) Patients are kept in ignorance of the time the operation is to be performed and are under treatment for some days. One hour before the operation scopolamin is given. (2) Ether or gas is substituted for the inhalations of aromatics, which have been a part of the preparatory treatment. (3) A local anesthetic is injected into the field of operation to prevent deleterious impressions from being conveyed to the brain, thus lessening the amount of general anesthetic used.

Ligation.—The ligation of vessels as an operative procedure was performed in the early part of the nineteenth century and later revived by Wölfler. The ligation of the *superior thyroid* arteries is made through a transverse incision over the center of the thyroid cartilage. The incision is made through skin and platysma muscles. Blunt dissection with spreading probe-pointed scissors exposes the inner border of the sternomastoid muscle, which is drawn outward. The anterior belly of the omohyoid muscle is next exposed, elevated, and drawn inward, which brings into view the upper pole of the thyroid with its vessels. A ligature of linen is passed around these veins and arteries, close to the gland or even including its tip. This prevents reversal of circulation by vessel-anastomosis, which occurs from high ligation of the artery. Injury to the nerve is not feared, as here the operation is made between the superior and inferior laryngeal nerves and the gland is easily approached. No drainage is necessary. According to the purpose of the operation, and to the condition of the patient, one or both sides may be ligated at the same time.

Ligation of the *inferior thyroid* artery is made through a lower transverse incision and requires elevation of the lobe of the thyroid. It is advisable to elevate and expose the gland at the point the ligature is applied, so that nerve tissue may not be included. This operation is usually done only in association with partial thyroidectomy. Operating thus in stages may be advisable in certain cases, especially of exophthalmic goiter. For example, the upper left pole may be ligated under cocain, and, when a few days later a second ligation is made, there is but little reaction. If the primary operation has been made without marked bad effect upon the patient, the secondary operation of thyroidectomy can be done in about a week. In the cases in which only double ligation has been done at an earlier period, part of the gland may be removed at the end of four months. By this time

[1] Surg., Gyn., and Obstet., Aug., 1911, pp. 170–173.

the patients who have been under weight will have gained an average of 22 pounds, and the thyroidectomy can be made with safety.

Thyroidectomy.—The angular or bayonet incision is made for the removal of high-lying goiters which have developed in the upper pole of the gland. The best general exposure of the thyroid is through a low collar incision, commonly known as the Kocher incision, which includes the skin and platysma and extends laterally to the external jugulars. The skin with platysma is dissected upward, also downward, uncovering the sternohyoid muscles. These are separated by a vertical incision which includes the fibrous capsule over the gland. Lateral traction, separating the two sternohyoid and also the sternothyroid beneath them, exposes the thyroid gland sufficiently and gives enough room for the removal of small goiters. However, in large and in exophthalmic goiters it is necessary to divide the sternohyoid muscle in the upper part of the field over the thyroid cartilage. This is important, since, when reunited, it preserves the nerve-supply and breaks the line of closure of skin and muscle, preventing a muscle-drawn scar which moves with deglutition. The sternohyoid can usually be retracted, but should be divided if it limits the working field. Many of the troubles and accidents in the surgery of goiter would be avoided if the preliminary exposure of the thyroid were adequate before proceeding with the gland itself.

The lateral veins are caught and divided between clamps. The gland is gently elevated with the hand, and, under slight tension, the vessels at the upper pole are caught and divided between forceps. This is repeated on the anastomosing vessels close to the isthmus. The vessels at the lower pole are treated in the same manner, the gland being held in the hands of an assistant, who keeps up continual traction, gradually elevating and turning with the isthmus across the trachea, where the separation is made along the opposite lateral lobe. Few forceps are required in simple goiters, while the papillary and exophthalmic forms require many. However, in the excision of an exophthalmic goiter one must keep close to the gland, and it is well to divide the capsule along the lateral border, which is caught in many clamps, and the gland more carefully enucleated, saving this capsule, which effectually protects the recurrent laryngeal nerves and also the parathyroids. (See Vol. V., Fig. 442, p. 949.)

Enucleation of Goiter.—In some instances encapsulated adenomata may be readily shelled out of the gland, preserving the remainder of the thyroid. The capsule of the thyroid gland is incised where the tumor comes nearest its surface, the lobe of the thyroid is elevated, and, under some tension to check the oozing, the rounded tumor is rapidly enucleated from the lobe. While under tension the sutures are applied through and through, and also within the space occupied by the tumor, to control the capillary oozing.

Resection of Mikulicz.—In large bilateral colloid growths it is often advisable to remove sections of both lobes. Mikulicz sliced a large wedge out of each side to reduce the gland to the desired size, the sur-

faces being approximated and the hemorrhage controlled by suturing. In such cases the isthmus must often be divided to permit the new lobes to separate from the trachea. This procedure greatly improves the after-appearance of the patient.

Exenteration.—This is another method of reducing the size of these large colloid goiters by curetment.

Combined Methods.—Combined methods indicate themselves according to the shape, size, and type of thyroid disease present.

Injection of Boiling Water.—Injection of boiling water into the substance of the gland, as recommended in cirsoid aneurysm, has been used by Miles Porter with marked success. Several treatments may be necessary before extirpation is advisable.

Quantity to be Removed.—The preservation of a quantity equal to one-sixth of the healthy gland is probably sufficient to prevent myxedema, but we should, if possible, leave more than that if we are compelled to operate on both lobes, since the cells are not all active. That factors of safety are becoming recognized in operating for exophthalmic goiter is shown by the great reduction in mortality. From a 20 to 30 per cent. mortality of twenty years ago, which, to be sure, followed operations on the most serious cases only, to a mortality at the present time of 1 to 4 per cent.

Parathyroids.—The parathyroids, four in number, two on each side, rest behind the capsule of the gland. While it is possible that a deficiency of one or two parathyroids will not cause hypoparathyroidism, inasmuch as we do not know the actual condition of the individual glands, one or more of which are often rendered useless by hemorrhage or degenerative changes from birth, it is essential to preserve them. It is, therefore, advisable not to remove any adjacent glands or gland-like bodies during operation upon the thyroid. Should one be accidentally excised, it should be transplanted beneath the capsule of the remaining thyroid lobe at the close of the operation. (See Chapter LXXVIII., Vol. V., p. 948, and Chapter CXIII., Vol. VI., p. 343.)

Tetany following thyroidectomy is undoubtedly due to hypoparathyroidism, and while treatment is not reliable, the experimental work of MacCallum and Voegtlin, together with the clinical and histologic observations of Erdheim, Strada, Yanase, Haberfeld, Thompson, and others, suggest certain principles to be followed. First, restoration of the calcium salts deficiency by administering acetate or lactate of calcium salts in 4 or 5 per cent. solution subcutaneously, repeated at intervals of some hours until relief is obtained. Second, transplanting human parathyroids unless relief is obtained from calcium alone. Third, various parathyroid serums are in the market and may be used in extreme cases.

Closure of Wound.—At the close of the operation the severed muscles are reunited with catgut, and the platysma myoides muscle is also reunited to prevent separation of the scar. No drainage is required after the removal of small tumors. As a rule, however, a drainage-tube is advisable for twenty-four hours. After the removal of large sub-

sternal goiters drainage should be shortened to a few hours, as the healing must be by blood-clot.

Nerve Complication: Paralysis.—All patients with goiter should have a laryngoscopic examination before operation to determine the condition of the vocal chords. More than one-fourth of the cases of so-called simple or colloid goiter and adenomata which show symptoms of pressure elevation, show also more or less paresis or paralysis of the abductor, adductor, or both, even though it may not be recognizable or noticeable clinically in the voice. Peculiarly enough, the left nerve, which is located somewhat deeper than the right, is more commonly subjected to pressure from rotation of the trachea caused by tumors on the right side and direct tumors on the left side. In fact, a considerable proportion of right-sided adenomata produce a paralysis of the left recurrent nerve.

Complications: Substernal and Intrathoracic Goiter.—The whole of a lobe or a portion thereof is not infrequently found behind the sternum. Such thyroids are usually of the adenomatous type, and can be readily removed by exercising great care in grasping and ligating veins and in obtaining a complete exposure of the lower region of the neck. A large tablespoon frequently is convenient in elevating the buried portion of the gland after it has been thoroughly separated by the finger.

Operations on Malignant Goiter.—Operations on malignant tumors of the thyroid (carcinomata and sarcomata), to be effective, must be made early and before the glands are extensively involved. The thyroid must be completely removed, saving the parathyroids. When done thus early the operation may give relief for a long period; late operations are at best but palliative and often inadvisable.

Aberrant thyroids are those islands of tissue which are separated completely from the normal gland, while accessory thyroids have some degree of attachment to it. They are all found in the lines of embryonic development or are dragged down into a substernal position in the descent of the thymus gland.

OPERATIVE RESULTS.

Simple Goiter.—Operations for cosmetic, prophylaxis, and indications of pressure, are, with few exceptions, extremely satisfactory. The mortality in these cases is but a fraction of 1 per cent. Patients with thyrotoxicosis occurring in simple goiter come to the surgeon on an average of about two years after the onset of toxic symptoms. At this time permanent injury to vital organs has frequently occurred. Operation can only prevent further damage and permit nature to repair that which has already been accomplished.

The results of thyroidectomy, aside from operations for the above indications, are determined largely by the following factors: (*a*) Amount of secretion; (*b*) the amount of resistance of patients' tissues, and (*c*) the extent of secondary lesions in patients' vital organs before coming to operation.

In exophthalmic goiter the degree of intoxication is generally proportionate to the extent of the hyperplasia.

The surgical treatment is perhaps not ideal, since it is an ablation and not a complete extirpation of the offending tissue. If the intoxication be intense, removal of a portion of the gland may only mitigate the symptoms, while if the intoxication be less, the amount of secretion may be so reduced that it can be cared for without producing marked symptoms.

When a case is operated upon during the period of progressive hyperplasia, the remaining portion of the gland may later functionate to a higher degree than did the entire gland at the time of operation. In such instances it is a fair assumption that without operation the entire gland might have furnished sufficient secretion to have killed the patient.

The percentage of cures following operation for thyrotoxicosis in both simple and exophthalmic cases depends entirely upon what we consider to constitute a cure. *Seventy-five per cent. of our cases*, most of whom had previously been a burden to themselves and their friends, were relieved and have been able to maintain a comfortable and fairly productive life. It is true that many are hampered by a more or less damaged heart, an irritable nervous system, or tachycardia on excitement or exertion, though the pulse-rate may be normal under ordinary circumstances. The remaining 25 per cent. of patients, while more or less improved, are still far from well, owing to extensive secondary changes in vital organs. Because of relapses a small number require a second operation for removal of more gland.

In general, it may be said that ligation and thyroidectomy have materially reduced the permanent disability and mortality from thyrotoxicosis, though lack of definite knowledge of the average natural course of the disease and of satisfactorily compiled statistics make it impossible to determine to just what degree this is true.

CHAPTER CXIII.

PARATHYROIDS.[1]

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The parathyroids were first described by Sandström (1880), who regarded these structures as embryonic rests of thyroidal tissue, and on his observations was based the *embryonic theory*. From that time until 1891 little attention was given to these glands. Gley (1891–93), basing his opinion on the effects of experimental ablation, claimed for the parathyroids essentially vital importance, and this gave rise to the *vitally essential theory*.

In reviewing the investigations which have been made since the observations of Gley, we find that a considerable amount of experimental, pathologico-anatomic, and clinical work has been done, but aside from possessing positive proof that the *embryonic theory* of Sandström is untenable, and knowing that the parathyroids are functionating anatomic structures concerned in body metabolism, consequently of pathologic importance, our knowledge of these glands remains, for the most part, indefinite. Whereas the more recent investigations seem to have made some definite advancement toward the truth, yet a careful analysis of them rather reveals the paucity of exact statements which may be made on the physiologic and pathologic importance of these structures.

After a general survey of the field, I have decided to confine myself principally to a phase of this study which has in recent times contributed some seemingly substantial data. In thus limiting myself, however, I do not wish to detract in the slightest degree from those commendable observations which have been otherwise made.

It seems now a well-established fact that many diseases which have been attributed to the parathyroids have not had their etiologic relationship supported by the more exact methods of investigation. Errors have crept into the literature through deductions which have been made from unsound premises. Defective experimentation, inadequate methods of histologic examination, misinterpretation of the findings, failure to study all the parathyroidal tissue of a case, together with conclusions based on the administration of therapeutic agents, such as parathyroidin, have resulted in a considerable confusion of the question.

Recent pathologico-anatomic studies (Erdheim, Yanase, Strada, Haberfeld) seem to have confirmed the experimental observation of

[1] Supplementary to Chapter LXXVIII., Vol. V., p. 948.

an etiologic relationship between the parathyroids and *tetany*, and to have discredited the causal importance of these glands in some other diseases. Haberfeld says: "Thanks to the investigations of recent years we are to-day fully justified in looking upon *experimental tetany* as the result of a total or partial parathyroidectomy, and that the clinical picture of experimental tetany is to be considered as the expression of a *hypothyroidism* of the organism." This author further states that tetany occurring after thyroidectomy performed on man may, in a certain sense, be reckoned with experimental tetany.

Recent histologic examinations have contributed support to the experimental work whose results indicate the significance of the parathyroids in tetany, and these investigations will here be chiefly discussed.

FIG. 138.—THE THYROID GLAND AND PARATHYROID GLANDULES: BLOOD-SUPPLY (POSTERIOR VIEW). (Halsted and Evans.)

As is commonly known, the principal diagnostic points of tetany are *Trousseau's sign*, a peculiar tonic spasm of the fingers and thumb, the so-called "obstetric hand," produced by prolonged, severe pressure upon the nerve-trunks, particularly the median nerve; *Chvostek's sign*, twitching of the facial muscles, elicited by tapping upon the trunk of the facial nerve, upon the malar bone, or over the infra-orbital foramen; *Erb's sign*, galvanic hyperirritability of the muscles which contract to very weak currents; *Hoffmann's sign*, extreme sensitiveness to the induced current. The spontaneous attacks are usually bilateral, often associated with intense pain, sometimes with slight edema of the face, hands, and feet, and the latter have a tendency to assume a partial equino-varus position.

Pathologico-anatomic investigations seem to have shown that *hemorrhages* in the parathyroids have a positive significance in the causation of tetany, especially *tetania infantum*, and that these hemorrhages produce their effect by causing a *hypoplasia* of the glands. *Hypoplasia* of the parathyroids manifests itself grossly by an abnormal smallness of these structures. Because of their known extraordinary variations in size, both in the same individual and among different individuals, this condition would not be an undeniable indication of hypoplasia, but a gland which presents a size only one-half that of the glands of the newborn might be suspected of deficient development.

Histologic examinations which were made on continuous serial sections, and in which not only the usual, but also chemico-histologic methods were employed, have demonstrated hypoplastic changes in the parathyroids as a result of hemorrhages. These studies have shown that even superficial inspection of the normal microscopic sections from a child reveals a difference between the color of the center and that of the periphery, the former appearing much more deeply stained than the latter. On more exact examination the cells of the center are seen to be excessively small, with narrow, densely stained protoplasm and ill-defined limits, while the cells of the periphery present a much larger,

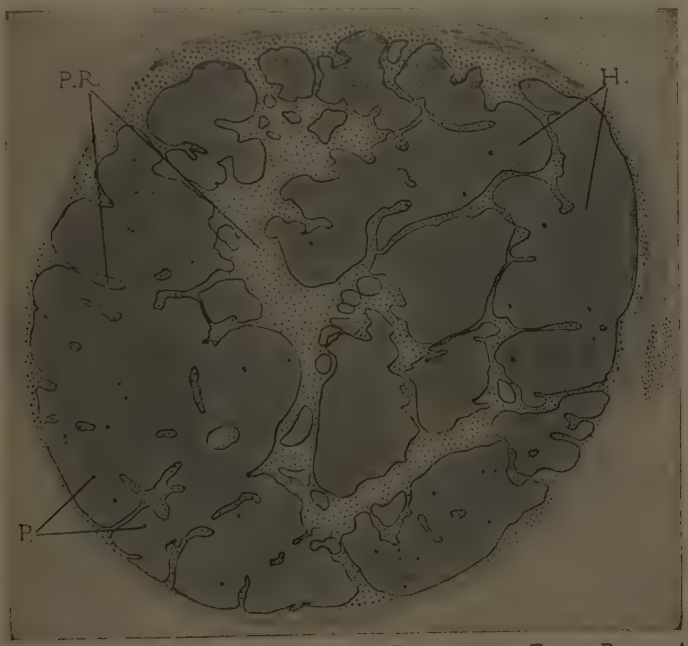

FIG. 139.—CROSS-SECTION THROUGH RIGHT SUPERIOR PARATHYROID. TETANY PATIENT AGED FIVE MONTHS. (After Haberfeld.)

Almost entire parathyroidal tissue destroyed by enormous hemorrhages, H. Remains of parenchyma in the center and as septa between the blood-cysts, P, R. Many phagocytes (P) with pigment in the blood-cysts, consequently signs of old hemorrhages. The zone of development completely absent.

lighter protoplasm, and sharp boundaries. These are the so-called "Wasserhellen" cells. This peripheral zone appears to be concerned in the development of the parathyroids, and since in cases of child tetany this light area was found wanting in places corresponding to blood-cysts, and intact in parts free from hemorrhage (Fig. 139), recent workers (Haberfeld, Yanase, *et al*) felt justified in making the positive statement that hemorrhages of the parathyroids injure these glands not only through disturbance of their tissue, but also by *inhibiting their growth.*

These hemorrhages manifest themselves as *blood-cysts* or merely as *hematogenous pigment.* It has not been possible to fix the exact time of

their occurrence, but many points favor Erdheim's view, namely, that they take place at the time of birth. In support of this opinion are very young cases (four weeks, four months old) presenting old hemorrhages, and the fact that the parathyroids are not disposed to bleeding, so that the mechanism of labor with its associated trauma may very likely play an important part.

Another point of interest which careful examinations have revealed is the frequent absence of valves in the veins of the affected glands, while the valves are present in the intact parathyroids of the same case. Deficiency in venous valves, therefore, has also been considered by recent investigators as contributing to the occurrence of hemorrhage, since in the presence of increased blood-pressure the valves can prevent bleeding.

Besides the older hemorrhages in the parathyroids, autopsies have revealed areas of recent bleeding in the pericardium and the pleura. The latter were probably the result of severe terminal spasms, but special methods of examination positively proved that the former antedated the beginning of the convulsive attacks. Recent hemorrhages have also been found in old blood-cysts, and it is assumed that their occurrence is also favored by the absence of valves in the veins.

Hitherto the hemorrhagic theory was questioned and the objection brought forward that tetany had never occurred at the time of the bleeding, but, instead, that it manifested itself very often only after the hemorrhages had been completely healed. That injury of the parathyroids takes place at the time of bleeding is to be admitted, and that signs of tetany do not occur simultaneously with the injury are facts which appear to be grounds for rejecting this theory. Escherich explains this apparent contradiction. This author states that the central nervous system of the newborn is so insensitive that the clinical picture of tetany cannot manifest itself, and that such manifestation is only possible beginning with the third month. Escherich's view seems to be supported by the facts that the brain of the fetus contains the highest amount of calcium (Quest) and that here calcium decreases with advancing age. Sabbatini has demonstrated that cerebral irritability is lowered by an increase of calcium and raised by the withdrawal of the same. Therefore, it is concluded, tetany does not occur at the time of bleeding, because at this period the irritability of the brain is very slight, which is due to the presence of a larger amount of calcium.

With regard to the question of calcium in its relation to tetany, the writer refers to recent observations by MacCallum and Voegtlin. These investigators have undertaken a study of the calcium metabolism of animals, in which this disease is produced by parathyroidectomy, and of the relations of various salts to experimental tetany, especially the salts of calcium. They state that all violent symptoms produced by parathyroidectomy—muscular twitching and rigidity, tachypnea, fibrillary tremors, increased rapidity of the heart-beat, etc.—may be almost instantly cured by the intravenous injection of a solution of a calcium salt. The acetate or lactate in 5 per cent. solution is usually

employed. Subcutaneous injection or the introduction of the solution into the stomach are quite as effective, but act more slowly. The condition of relief lasts for perhaps twenty-four hours, when tetany may reappear. Analysis of the blood taken from a dog during tetany shows a calcium-content which is only about half that of the normal dog on the same diet. MacCallum and Voegtlin are at work on the analysis of the brain, muscles, and other tissues, and their results are looked forward to with especial interest. They state that from their observations, up to the present, it is possible to construct at least a plausible, working hypothesis to explain their results. Apparently the parathyroids control in some way the calcium metabolism, so that upon their removal a rapid excretion, possibly associated with inadequate absorption and assimilation, deprives the tissues of calcium salts. In the case of tetany the central nervous system seems to be especially affected,

FIG. 140.—SMALL AREA OF PARATHYROID. TETANY PATIENT AGED FIVE MONTHS. (After Haberfeld.)

C, Small dark cells of the center; D, zone of development showing large light cells which are absent at B, replaced by blood-cysts (old hemorrhages).

as has been shown by experiments in which muscles isolated from nervous control showed no twitching during the attacks.

Aside from these and other factors which may be concerned in producing tetany at the third month or even later, supporters of the hemorrhagic theory explain the question as follows: All their experiences with experimental tetany have shown that *insufficiency* of the *parathyroids* is necessary for the production of tetany. This insufficiency occurs in experiments through removal of parathyroidal tissue. In the *idiopathic tetany* of man, however, it is caused by an injury of these glands in consequence of pathologic processes. In children there have been found hemorrhages which, when they were relatively fresh and large (blood-cysts), showed evident severe injury of the parathyroids (Fig. 140). But how is the insufficiency (and therewith the tetany) to be explained when even before the outbreak of the disease these blood-cysts have been gradually absorbed and only more or less blood-pigment is to be found. As Erdheim has stated, by itself this

pigment can scarcely produce injury of the parenchyma, but, in spite of that fact, it must be looked upon as the expression of a tissue injury which causes insufficiency of the parathyroids.

Whereas it is not supposed that every hemorrhage in these glands produces hypoplasia, yet Yanase was never able to demonstrate clinically normal galvanic irritability in any child whose parathyroids showed anatomically hemorrhages even in slight amount. This is an important point, since in some cases the glands are apparently normal. Tetany is not to be explained by the injury of these structures alone. There have been cases in which the glands were undoubtedly injured, that is, parathyroids disposed to tetany, but the attacks did not occur until another factor entered, for example, gastro-intestinal disease. Therefore these patients lived for many years with defective parathyroidal tissue, and were not seized with tetany until hypofunction of their glands was produced by a contributing factor.

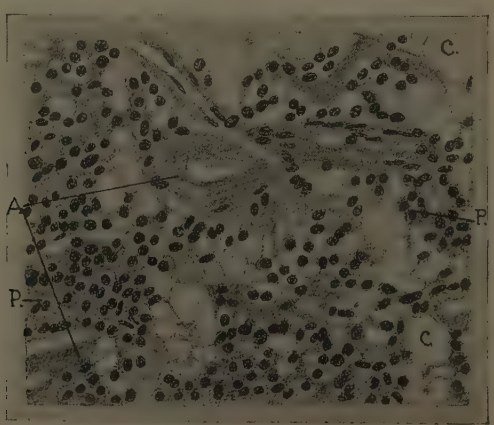

FIG. 141.—TETANY PATIENT AGED TWENTY-FOUR YEARS. AMYLOID DEGENERATION OF SMALL VESSELS. (After Haberfeld.)

A, Cells near vessels show hydropsical degeneration, absence of nuclei, and swelling of protoplasm; C, loss of cell membrane with cavity formation; P, normal appearing parathyroidal cells.

Besides the hyperplasia resulting from hemorrhages, other conditions have been noted in association with deficient development and insufficiency of the parathyroids. Haberfeld cites 2 cases of congenital syphilis, one four weeks, the other six weeks old, both manifesting signs of tetany. In each the glands were abnormally small—one-half the normal size in the newborn. The cells throughout were small and dark and the principal cells of the periphery (zone of development) were entirely wanting. Since, together with these changes, hemorrhages were also present, the author could not decide whether the histologic findings were due to the hemorrhages of the syphilis that was present, but believed that the latter had a considerable part in the hypoplastic changes, because of the fact that the degree of hypoplasia was the same both in the glands free from hemorrhage and in those where a small amount was present.

Tetania Adultorum.—Only a few thoroughly examined cases have been described in the literature. One of these was a patient in the clinic of Prof. Kovacs, Vienna, 1907. The case was investigated and reported by Haberfeld. Age, thirty-one years. Previous history of rachitis and the infectious diseases of childhood, including scarlet fever. Fourteen months before death a severe attack of enteritis, which terminated in fatal peritonitis. During the last five months the patient suffered from tetany. *Autopsy* (Wiesner): Old enteritis, fresh serofibrinous peritonitis, amyloid nephritis, amyloidosis of the spleen, chronic edema of the brain, thickening and cloudiness of the leptomeninges. *Parathyroids:* Number and size normal. *Histology:* In two of the glands extensive inflammatory infiltration around the larger veins; extensive amyloid degeneration of the smaller vessels, similar to the process in the kidneys and the spleen, and *hydropsical degeneration of the principal cells*, which produced numerous degenerative cysts in the parenchyma (Fig. 142).

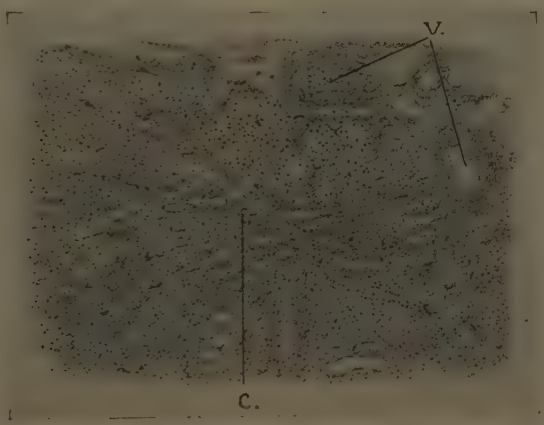

FIG. 142.—TETANIA GRAVIDARUM. PATIENT AGED THIRTY-ONE YEARS (×50). (After Haberfeld.) Area of a parathyroid showing moderately large, radiating cicatrix (C); vessels (V).

In this case the parathyroids were injured, and consequently, as maintained by Haberfeld, became insufficient for the neutralization of the toxic metabolic product which leads to tetany. This author states that it is justifiable to suppose that in gastro-intestinal diseases these toxins of tetany are produced in an increased amount.

Tetania Gravidarum.—This form of tetany is characterized by the facts that a woman who had previously manifested no signs of tetany is attacked with the disease in the course of a pregnancy; that the attack may occur during the first pregnancy and afterward in each succeeding one, appearing with the same or increased intensity, or the tetany may manifest itself for the first time in a later pregnancy. Haberfeld was the first to examine the parathyroids in a case of spontaneous tetany of this form. This was a patient in the Shauta clinic, Vienna, 1907. All four of the parathyroids showed pathologic changes. Two presented

large scars, in the regions of which there were parenchymatous atrophy and small cysts. In one gland round-celled infiltration was present, and in the fourth such extensive atrophy that scarcely any epithelial cells remained (Figs. 143, 144).

In his discussion the writer says: "This first case of idiopathic tetany of pregnancy in which the parathyroids have been examined teaches us that just as in the cases of *tetania gravidarum experimentally* produced, the tetany is to be considered undoubtedly in connection with the parathyroids—it is due to a *hypoparathyroidism*, . . . that

FIG. 143.—SAME CASE AS FIG. 142 (× 125). (After Haberfeld.)

Part of the cicatrix (C) is seen. Individual epithelial cells in this region swollen, in places uniting and forming small cavities (D, E); vessels (V).

FIG. 144.—SAME CASE AS FIGS. 142 AND 143 (× 160). (After Haberfeld.)

Small area of a parathyroid which is almost completely atrophied. The section shows for the most part connective-tissue bands bearing many small vessels. Remains of original parenchyma (P); vessels (V).

also in the case of the human it is no longer merely a theory nor a deduction, but a fact."

Therefore, basing their conclusions on experimental clinical and pathologico-anatomic investigations, recent writers state that the principal factor in the production of tetany is *insufficiency of the parathyroids*. This insufficiency may be either *absolute*, that is, referred alone to the glands, as by their absence (operative tetany), or *relative*, in which case the parathyroids are hypoplastic, consequently disposed to tetany, and hypofunction is produced by a contributing factor, as, for example, gastro-intestinal disease. The latter form seems from investigation to be the more frequent and, for the tetany of children, is almost a law.

Accordingly, injury of these glands is to be regarded as disposing to

tetany, while the releasing factor, whose nature still remains obscure, is undoubtedly of a very varying kind (infection, pregnancy, etc.).

It has further been shown that theories based on the importance of the oxyphilic cells and colloid are untenable, recent authors maintaining that these elements are signs of senility of the organ. There is no anatomic proof to support the view of Vassale and Zanfrognini as to the etiologic relationship between the parathyroids and eclampsia gravidarum. The differences in the clinical pictures of tetany and eclampsia also make this view unlikely. Lundborg and Chvostek's hypothesis as to the importance of these glands in *myasthenia gravis* has not been substantiated by anatomic examination. Erdheim has shown that hyperplasia of the parathyroids is associated with osteomalacia, but as a sequence of this disease.

Surgical Importance of the Parathyroids.—Viewed in the light of our present knowledge, these glands are to be regarded as structures possessing a function that is essential at least for the normal metabolism of the organism. Although the results of animal experimentation are not uniform with regard to some points, yet they have proved that removal of parathyroidal tissue is followed by a condition termed *experimental tetany*. Histologic examinations have shown pathologic changes in the parathyroids of typical cases of *spontaneous tetany*, and some of these changes seem to be the result of trauma.

Guided by these scientifically supported facts, the surgeon should scrupulously guard against removal or injury of these glands. Remembering their variable size, location, and appearance, the operator should preserve all small, especially gland-like masses about the capsule in case of operation on the thyroid gland. If such a mass be accidentally removed in the course of operation, it should at once be implanted beneath some part of the remaining capsule.

Having in mind the possibility of tetany following operation on the thyroid, we might fall into the error of diagnosing a tetanoid attack as genuine tetany. But when we consider the nervous effects of hyperthyroidism, it should not be surprising to find a patient who had undergone an operation for exophthalmic goiter presenting nervous signs such as to arouse suspicion. Cases of this kind have been observed, but the diagnostic points of tetany were wanting, and the results indicated that the condition was probably hysteroidal.

No reliable treatment for tetany is at present known, but the experimental work of MacCallum, Voegtlin, and others and the observations of Haberfeld on a series of spontaneous tetany suggest certain principles to be followed. According to these investigations, deficient parathyroidal tissue is the principal causal factor in the condition, consequently the ideal treatment would be to make up this deficiency by transplanting parathyroids from other persons, feeding with animal glands, the use of serum, or the extract of parathyroid. Unfortunately, none of these procedures have given dependable results. To restore the balance in calcium metabolism seems also indicated, and for this purpose calcium salts, acetate or lactate (in 4 or 5 per cent. solution),

should be administered intravenously, subcutaneously, by stomach, or rectal enemata. In order to avoid those factors which contribute to the attacks by increasing the toxic metabolic product, the patient's general condition, especially his gastro-intestinal tract, should be given most careful attention.

In 3067 operations on the thyroid gland at St. Mary's Hospital (Mayo Clinic), the total up to August 11, 1911, but one patient is known by us to have manifested signs suggestive of tetany.

Case: G. H. S., female, aged forty-five years. Clinical diagnosis, simple goiter. Family history, one sister had goiter. Personal history, two operations for lacerated perineum, last one eleven years ago. Sciatica, right leg, five years ago. Right lobe of thyroid gland enlarged for twenty-five years, left lobe for twelve years. Growing more rapidly the past three months, during which time the patient became nervous and suffered from dyspnea. Rather despondent for last six months. No edema. Able to do regular work up to present time.

Operation August 11, 1911 (St. Mary's Hospital), partial thyroidectomy, enucleation of cysts. Pathologic diagnosis, adenomata; cystic degeneration.

Postoperative course: August 12, patient complained of stiffness in fingers and face, and tingling in legs. Fingers rigid and partially flexed at metacarpophalangeal joints; thumbs in palms; toes also flexed. August 13, patient complained of a decided increase of symptoms. Treatment: 2.0 gm. calcium lactate subcutaneously; thyroid extract, .30 gm. every four hours for three doses; calcium lactate, .60 gm. three times a day by mouth; trional, .60 gm. at night. August 14, rigidity less and gradually diminished until the sixth day after operation, when it disappeared entirely. August 19, patient discharged from hospital.

It is questionable whether in this case genuine tetany was present, since some of the diagnostic points were wanting. The fact that symptoms subsided so soon after treatment might be suggestive, but a deduction from such unreliable premises would lead to error, especially since the signs did not reappear, and thyroid instead of parathyroid extract was used. Experimental evidence shows that whereas tetany is relieved by the administration of calcium salts, yet the attacks tend to recur after about twenty-four hours.

Extract of thyroid gland was administered, but the indication for its employment is not supported by scientific investigations. Even parathyroid extract has failed to produce effects in some cases of undoubted tetany (parathyroids removed at operation), although the treatment was continued for months.

Adhering closely to the view of parathyroidal causality in tetany, if the above was a genuine attack, either the parathyroids were already hypoplastic and rendered temporarily insufficient by the operative procedure and postoperative disturbances, or they were injured during operation, in which case an unusual location must be assumed, since only enucleation was performed on the thyroid gland of this patient. Finally, when the increasing nervous condition of the patient during the past several months is considered, the possibility of the manifestations having been hysteroidal should be kept in mind.[1]

[1] The author is indebted to Dr. Bernard Francis McGrath for translating the literature on this subject and for compiling and arranging the pathologic data incorporated in the chapter.

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CHAPTER CXIV.

THE NOSE AND ITS ACCESSORY SINUSES.*

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Nasal Deformities.—Paraffin, when subcutaneoulsy injected with the proper observance of the precautions previously emphasized (Vol. III., p. 406), furnishes the most feasible means of correcting depressed nasal deformities. However, there are instances when the nasal bones and the nasal processes of the superior maxillary bones have been flattened out, so that if paraffin is injected upon this flattened base it results in an increased deformity. In such cases it is best to mobilize the misplaced bones and reset them in their proper position. The difficulty of preserving the integrity of their relation has been largely overcome by the use of the bridge-splint devised by Dr. W. W. Carter.[1] This instrument, besides holding up the bridge of the nose, creates lateral pressure upon the base of the nasal triangle which overcomes the tendency of the broken bones to override laterally the superior maxilla. The application of this method of correction is particularly well adapted to those cases where paraffin injection is inadequate. A third class of depressed deformities of the nose is that where great destruction of bone and tissue has taken place, and which cannot be overcome by either the injection of paraffin or by the use of the bridge-splint. These may be overcome by the insertion of a rib-splint beneath the tissues. Carter[2] has successfully employed this method in 9 cases. He says: "The skin over the nose and over the ninth rib on the right side is prepared for an aseptic operation. A short transverse incision is made down to the bone at the nasofrontal suture. Through this incision the skin and subcutaneous tissues over the dorsum of the nose are elevated with a long, thin, two-edged knife, curved on the flat. (A Seiler septal knife answers the purpose very well.) Above this incision the tissues, including the periosteum, are elevated for about $\frac{3}{8}$ inch. This wound is covered with sterile gauze. The ninth rib at about its middle is then exposed for 2 inches, shelled out of the periosteum, and removed. This section of rib is then split in its transverse diameter, its medullary portion scraped off, and one of the strips of bone

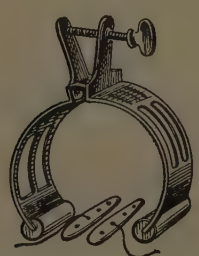

Fig. 145.—Carter's Bridge-splint.

* Supplementary to Chapter XXXIX., Vol. III., p. 399.

is shaped to suit the deformity. This is then inserted into the wound in the nose previously made for its reception, care being taken to insert the upper end under the periosteum over the nasofrontal process. Both wounds are then irrigated with sterile salt solution, closed with silk sutures, and sterile dressings applied."

Rhinoscleroma.—Until a few years ago scleroma was believed to be confined to Russia, Poland, and Prussia, but cases have recently been reported from nearly every other country of Europe, also from India and Japan. One American-born case has been reported by Wende, of Buffalo.

A greater number of these cases are now being recognized, owing primarily to the more definite methods of diagnosis at our disposal, and secondarily to the increased clinical facilities taken advantage of by the class in which scleroma is most frequently found.

Little was definitely known of the microscopic character of scleroma until Frisch[3] (1882) isolated a peculiar bacillus in the cells of the growth between them and in the interfibrillary spaces of the connective tissue.

Although this bacillus resembled the Friedländer bacillus in form and other characteristics, yet there seemed to be sufficient morphologic and biologic variations to classify it separately. This matter is discussed at length in the work of Kolle and Wassermann.[11]

In addition to the Frisch bacillus, Mikulicz[7] called attention to a very much swollen cell, which has since been known as the " foam cell," or the Mikulicz cell, which is always present in scleroma, although it is sometimes found in other lesions.

Lastly, Pellizzari[8] added another element of confirmation in the existence of a hyaline body called the Russel body.

A negative Wassermann reaction excludes syphilis, with which scleroma is often confounded. The initial lesion is usually upon the floor of the nose anteriorly, from which point it may spread posteriorly even to the larynx and trachea, and outwardly to the lips and to the external nose.

The only location which is free from invasion is the upper third of the interior of the nose, to which the olfactory nerve is distributed, hence the sense of smell is preserved even in markedly advanced cases.

Formerly it was supposed to be a disease of adult life, but Woekwitsch reports a case coming under his observation at twelve years of age, and Freudenthal another occurring at nine, while Rydygier, Jr.,[9] had 13 cases ranging in age from seven to twenty.

The etiology, while obscure, is sufficiently definite reasonably to ascribe it to poor food, bad hygiene, lowered vitality, or possibly some condition of soil or atmosphere that predisposes to the development of the bacillus of Frisch.

The skin lesions almost invariably heal under the application of the *x*-ray. A great number of them upon the mucous membranes clear up under similar treatment, especially if the ray can be brought directly against the invaded area. Vaccines as a therapeutic measure are still doubtful, though they appear to retard the progress of the disease.

The vaccine treatment has been tried by Güntzer[4] with apparently favorable results, although he claims more benefit from the *x*-ray than from the vaccines.

Sarcoma of the sinuses has always been so extensive and involved regions so far beyond the expectations of the operator that many surgeons hesitate to operate except for the relief of pain. Radium has offered a possible solution in some cases, and investigators of large experience claim marked results from its use.

The *x*-ray and other chemical rays have proved unavailing.

Empyema of the Sinuses.—At present the radical external operation upon the nasal accessory sinuses is resorted to with much less frequency than was the custom five years ago. This is due to the fact that our knowledge of the sinuses and their anatomic relation to the nasal chambers have increased, and we have devised methods of treatment which, if persistently and systematically applied, will in many instances overcome the difficulty. In cases where the above methods are unsuccessful, internal operative measures are resorted to before the external. The radiograph definitely determines the distance between the inner and outer table of the frontal sinus, and enables the operator to proceed with assurance to gain entrance into the sinus. Even the

Fig. 146.—The Curved Rasp of Good.

most ardent advocates of the external method now advise a preliminary internal operation, especially the removal of the middle turbinate, the eradication of the ethmoidal tract, and the opening of the sphenoidal sinus. When the middle turbinate has been removed it is necessary, in order properly to gain entrance into the frontal sinus through the frontonasal canal, to break down the bulla ethmoidalis, chisel away the processus uncinatus, and to pass a probe through the hiatus semilunaris into the frontal sinus. This probe may be utilized as a director to introduce the curved rasp of Good[4] into the sinus (Fig. 146). The rasp then cuts anteriorly and laterally away from the septum. Ample space is thus obtained properly to drain the sinus and permit of its irrigation without destroying its lining membrane.

It is undesirable to curet either the posterior wall of the hiatus or any part of the sinus, for this denudes the bone of its protection and induces necrosis. Irrigation through a curved cannula followed by injections of 25 per cent. solution of argyrol hastens recovery.

Granulations spring up rapidly and tend to occlude the opening, which should be reduced either by the use of fused nitrate of silver or by curetage. The opening may frequently be kept patulous by passing Freeman's graduated sinus probes into the sinus at each sitting. The

negative pressure advocated by Horn or any of the other methods of suction for the complete evacuation of the sinuses are aids in the treatment, but are not sufficient in themselves to perfect a cure. Persistent, careful, systematic, and frequent treatment will overcome many cases of empyema which appear to be beyond recovery except by the radical external operation. There are cases, however, of such a serious nature that the external operation is imperative, and delay for any internal procedure would be unwarranted. The radical external operation must be performed when there are symptoms of meningeal involvement; when the nasal chamber is occluded with multiple polypi which prevent drainage; when the purulent discharge is excessive and of foul character; when there is the general appearance of sepsis, together with a septic temperature; when the pus has broken through the outer table of the sinus into the orbit.

When the *x*-ray indicates a small sinus the Jansen operation (Vol. III., p. 435) seems to be the operation of choice, but in large sinuses the Killian (Vol III., p. 436) is by far the best. The attempt to save mucous membrane is ordinarily unsuccessful, and it is better to obtain free and perfect drainage by the destruction of more mucous membrane than it is to endanger drainage by destroying too little. When the external operation is performed it should be the endeavor of the operator to eradicate all diseased tissue in the frontal sinus, the ethmoid tract, and in the sphenoid, should this cavity be involved.

There may be exceptional cases necessitating external operative measures when the ethmoids have escaped invasion, but I have failed yet to find one; so that it is better to remove the entire ethmoidal tract at the time of the first operation than it is to leave an infective focus behind for subsequent removal. Tags of mucous membrane granulate and offer obstruction to drainage, and should be removed as thoroughly as possible.

Even the originators of the most radical surgical procedures are now modifying their views about the external operation and are assuming a more conservative attitude. Almost all of the acute sinus empyemata may be overcome by careful and persistent internal treatment. Those cases extending into the subacute stage may necessitate internal operative measures. In chronic cases the majority can be overcome by internal operations, followed by persistent treatment, while a few will necessitate the radical external operation to perfect a cure.

Empyema of the Sinuses in Relation to Optic Neuritis.—Visual disturbances, blindness, and the entire loss of the eye may result from empyema of the sphenoid, ethmoid, or frontal sinuses. In a recent case of my own it was necessary to remove the eye, which had become necrotic from neglected pansinusitis associated with orbital abscess. Visual disturbances are due to either a direct pressure upon the nerve, when the nerve runs through the sphenoidal sinus, or to an indirect pressure from hyperemia of the periosteum adjacent to the sinus and in contact with the nerve. Involvement of the nutrient vessels supplying the nerve sometimes occasions like symptoms.

In many instances blindness quickly follows the visual disturbance, and operative measures should be immediately instituted in cases of empyema of any of the sinuses when eye-symptoms are present. The oculist and rhinologist should work in close accord in these cases, as each is very dependent upon the other. Numerous instances are now on record where apparently hopeless cases of blindness have been relieved by operations upon the sinuses, particularly upon the sphenoid. Onodi, Loeb, Posey, Holmes, Coffin, and others have demonstrated the close anatomic relation between the optic nerve and the sinuses, and they have also shown the anatomic misplacement of the nerve and dehiscences of its bony covering.

When the nerve runs unprotected through the sphenoidal sinus it is particularly susceptible to infection and to pressure influences. When all other causes for optic neuritis other than sinus empyema have been eliminated, immediate operation is advisable, although there may exist no obtainable evidence of involvement. I have operated upon the sphenoid and posterior ethmoids at the request of the oculist for the relief of optic neuritis,[10] when the only evidence obtainable of previous

Fig. 147.—La Force's Adenotome.

sinus involvement was the history of a cold. In these cases I found a latent empyema. I operated upon these cases by the internal method, and recovery of vision followed in a few months' time.

Removal of Adenoids.—Surgeons have vacillated between radicalism and conservatism regarding the removal of the tonsil, but, apparently, all have agreed that the thorough removal of adenoid growths is advisable.

In the removal of adenoids the La Force adenotome (Fig. 147) has materially lessened the dangers of trauma to adjacent structures, and also has offered a safe and adequate method for their removal. The instrument is made in three sizes, the medium size being sufficient for nearly every purpose. It should be introduced behind the soft palate with the fenestra open. The handle is then lowered until the nose of the instrument is brought against the septum, then with firm pressure against the posterior pharyngeal wall the blade is pushed home. The closed head of the instrument retains the growth and the operator is always able to preserve the removed mass. It is necessary to use a small curet on both sides of the median cut, as the instrument cannot remove the growth from the fossa of Rosenmüller. It is also neces-

sary to curet high in the vault, as a small area of tissue is occasionally left close against the posterior border of the septum. There is possibly more hemorrhage following its use than from the curet, but not of sufficient quantity to be objectionable.

Removal of Tonsils.—Definite conclusion has not been reached relative to the extirpation of diseased tonsils. Some operators insist that the tonsil with its capsule should be removed in each instance, while others are far less radical.

For the past two years many operators have assumed a less radical attitude than formerly toward the removal of simple hypertrophied tonsils. There are also a few who advocate the removal of tonsils only when they are affecting the general health; or when they are buried and have large open crypts through which the invasion of micro-organisms reach the glands of the neck; or when they are subject to frequent attacks of inflammation. When the tonsil is hypertrophied and only encroaches upon the pharyngeal space, without constitutional manifestations, the conservative operator refuses to remove them.

It is universally understood that the diseased and buried tonsil associated with glandular involvement should be thoroughly removed, irrespective of its size. This small diseased tonsil menaces health more than the large, smooth, hypertrophied variety.

FIG. 148.—HURD'S SPOON-SHAPED SEPARATOR.

There are some who strongly advocate the finger dissection, in which the plica is cut with scissors well up into the supratonsillar fossa, and the tonsil is removed from its enveloping sheath by the index-finger, sometimes with its capsule attached. This method is safe and complete, but the trauma resulting is the same as that incident to any blunt dissection.

In the enucleation of tonsils the cold wire snare has probably more advocates than any other one method. The tonsil is grasped with tenaculum forceps or hook and drawn well out of its bed, while the folds are liberated anteriorly and posteriorly with a sharp spoon-shaped separator (Fig. 148). When the tonsil is liberated and remains only attached by its base, the snare is passed over the handle of the tenaculum and looped around it, and the loop is drawn together either by hand pressure or by the screw windlass of the snare. Considerable trauma has resulted from the use of the snare, and cicatrices have resulted in some cases between the tongue and the lateral pharyngeal wall. These fibrous formations have affected speech in certain instances, and in others, when the snare is used hurriedly, the hemorrhage is as great as that resulting from the use of any other instrument.

When the tonsil is properly liberated from its anterior fold, and the anesthetist can render aid in pushing the tonsil well outward and forward by external pressure, there is no instrument better qualified

to enucleate the tonsil with its capsule intact than the Mackenzie tonsillotome. To remove the tonsil properly in this manner, the selection of the instrument with a fenestra just larger than the tonsil is of the first importance (Fig. 149). The blade of the tonsillotome should be at right angles to the handle and reinforced beneath with a thick piece of metal, to insure against bending when hard pressure is made on the handle. The operator must familiarize himself thoroughly with the manipulation of the instrument. The anterior fold of one tonsil is liberated with the Leland knife and this tonsil is removed before the other one is touched. The nurse is thereby enabled to care for the side that is bleeding while the other tonsil is being removed, and the amount of blood lost during the operation is considerably lessened. Serious hemorrhage frequently lowers vitality and retards recovery.

Some operators are particularly skilled in the use of the Mathieu tonsillotome (Vol. III., p. 453), from the use of which there is less trauma and shock than from any other instrument. When using this

FIG. 149.—TONSILLOTOME.

it is best that the patient should be sitting up. If the instrument is made sufficiently heavy to withstand hard pressure, the tonsil can be engaged so that it will be removed as effectively as with the Mackenzie instrument.

Hemorrhage from the removal of adenoids is ordinarily overcome by forcibly injecting peroxid of hydrogen through the nares so that pressure is exercised against the soft palate and postpharyngeal wall by the disintegration of the blood. A solution of equal parts of tannic and gallic acid run through the nose is also effective. The postnasal tampon is almost always sure to stop it, but should not be left in place over twenty-four hours. Few fatalities have been reported from hemorrhage in this locality. Tonsillar hemorrhage when sufficient to become alarming can be met in the following order:

1. Apply locally on a sponge a thick solution of equal parts of tannic and gallic acid.

2. Dust compound alum powder over the bleeding surface.

3. Clasp the bleeding vessel with an artery forceps and tie if necessary.

4. Run a ligature through the anterior and posterior folds by means of a curved needle and tie off the bleeding area.

5. Apply one or more metal sutures in the anterior and posterior folds and bring them together at the bleeding-point by means of the Michel metal suture instrument (Fig. 150). These sutures must be removed in about twelve hours.

Fig. 150.—Michel's Metal Suture Clamp for Tonsillar Hemorrhage.

6. Apply the Mikulicz-Stoerk tonsillar hemostat (Vol. III., p. 454), which should be left on for not over twelve hours.

7. Ligate the external carotid. *Never* ligate the common carotid.

Oozing from the removal of tonsils or adenoids can be effectively controlled by the use of thrombokinase. This substance is the preferment of the blood furnished by the destruction of cellular elements. It was first prepared for clinical use by Batelli. Strong has perfected the method and has demonstrated the presence of a ferment body by heat inactivation. The essentials of the method are extraction of fresh

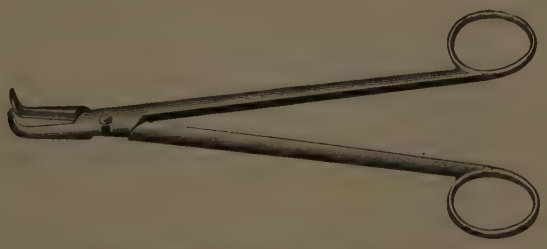

Fig. 151.—Michel's Metal Suture Extractor.

tissues by water and precipitation with acetic acid. A brownish powder results which is applied locally for the control of hemorrhage, with very satisfactory results. Thrombokinase is not yet upon the market, but may be obtained from the laboratory of the Manhattan Eye, Ear, and Throat Hospital, with the understanding that clinical observations following its use be furnished the laboratory.

Collapse of the Ala Nasi.—In addition to the many operations devised for the relief of a collapsed ala, MacKenty[6] has recently submitted one which gives more breathing space, as well as rendering the ala more fixed.

The primary incision begins high up on the septal side within the skin line near the mucocutaneous junction, and is carried downward and outward across the floor of the nose and upward into the ala (Fig. 152). The dissection includes the subcutaneous tissue and is carried backward until the bony ridge of the nasal floor is reached, when the periosteum is included in the elevation, which is continued for a little distance beyond the ridge. The ridge is removed laterally to include the transverse diameter of the entrance, and then downward until the floor of the nose and the entrance are on the same plane. A small thin gouge, chisel, or bone-forceps may be employed for this purpose. The base of the septum median to the ridge upon the nasal floor is chiseled away for about two-thirds of its thickness. The fat and areolar tissue attached to the flap are removed until nothing remains but the skin and mucous membrane.

FIG. 152.—MACKENTY'S OPERATION FOR COLLAPSED ALA: INITIAL INCISION.

If the operation has been successful up to this point the nasal floor will lie about $\frac{1}{2}$ to $\frac{2}{3}$ cm. below its original place and the flap will be too short to cover the denuded area. To minimize the contraction incident to healing, it is advisable to leave any necessarily bare area upon the septum rather than upon the floor of the nose, where it is desirous of obtaining the greatest possible transverse diameter. The flap is, therefore, incised at its apex on the septum, and the incision is carried backward and downward toward the floor of the nose to the extreme point of denudation (Fig. 153). The flap is lowered to the new floor, stitched in place with fine iodized catgut (Fig. 154), and the nostril packed with vaselin gauze. Or the flap may be held in place with a dental gutta-percha splint molded to meet the conformity of the nasal chamber. The splint should be worn for ten consecutive days, removing it only for cleansing. Then it should be replaced only at night for a week or more. General narcosis is best for these cases.

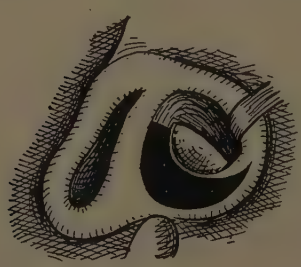

FIG. 153.—MACKENTY'S OPERATION FOR COLLAPSED ALA: SECOND STEP. LOWERING FLOOR OF NASAL VESTIBULE.

FIG. 154.—MACKENTY'S OPERATION FOR COLLAPSED ALA: SUTURES IN PLACE. LOCATION OF DENUDED AREA.

The dressings are changed for the first time on the seventh day and the sutures removed two days later.[12]

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CHAPTER CXV.

SURGERY OF THE LARYNX AND TRACHEA.*

By George Emerson Brewer, M. D.,

New York.

Since the publication in 1908 (Vol. III., p. 460) of the chapter on the Larynx and Trachea considerable progress has been made in the department of laryngology.

While this has not resulted in any revolutionary change in diagnostic methods or operative technic, there has been a steady advance in perfecting known operative procedures and a noticeable betterment in results. As many of the advances which have been made have been in the minor operative procedures and methods, interesting to the exclusive specialist rather than the general surgeon, and as the space allotted to this chapter is necessarily somewhat limited, I will attempt no general review of the progress of laryngology, but rather call attention to some of the more important advances in the major operative procedures which have appeared in the current literature of general surgery.

Laryngoscopy, Tracheoscopy, and Bronchoscopy.—In examinations of the larynx there has been a gradual tendency of late toward the general employment of direct laryngoscopy by one of the many instruments devised for this purpose. One of the most satisfactory of these is the Jackson direct laryngoscope (Fig. 155). By having the light near the spatula extremity the illumination is far more satisfactory, and the examination more easily made by one not accustomed to using the head-mirror or Kirstein's lamp.

The employment of tracheoscopy and bronchoscopy (described at length in Vol. III.) has been much more general during the past four years, not only for diagnosis, but also for the removal of foreign bodies.

The report of a large number of successful cases and the published description of a number of new and improved instruments indicate widespread interest, and attest the fact that the method is becoming popularized.

Crosby Greene, of Boston, has recently published the reports of some difficult cases, and calls attention to the labored breathing in children when exploring an occluded bronchus, on account of the necessarily large size of the tube, which interferes materially with the current of air from the other lung. He advises in these cases the employment of

* Supplementary to Chapter XV., Vol. III., p. 460.

a fenestrated tube, the opening being far enough from the distal extremity to insure the free passage of air from the trachea and opposite bronchus into the lumen of the tube.

Congenital Inspiratory Stridor.—Shukowsky[9] reported 3 grave examples of this condition, one of which was found to be due to inherited syphilis, a typic specific ulceration being present on the laryngeal mucous membrane, as well as gummatous nodules on the tongue,

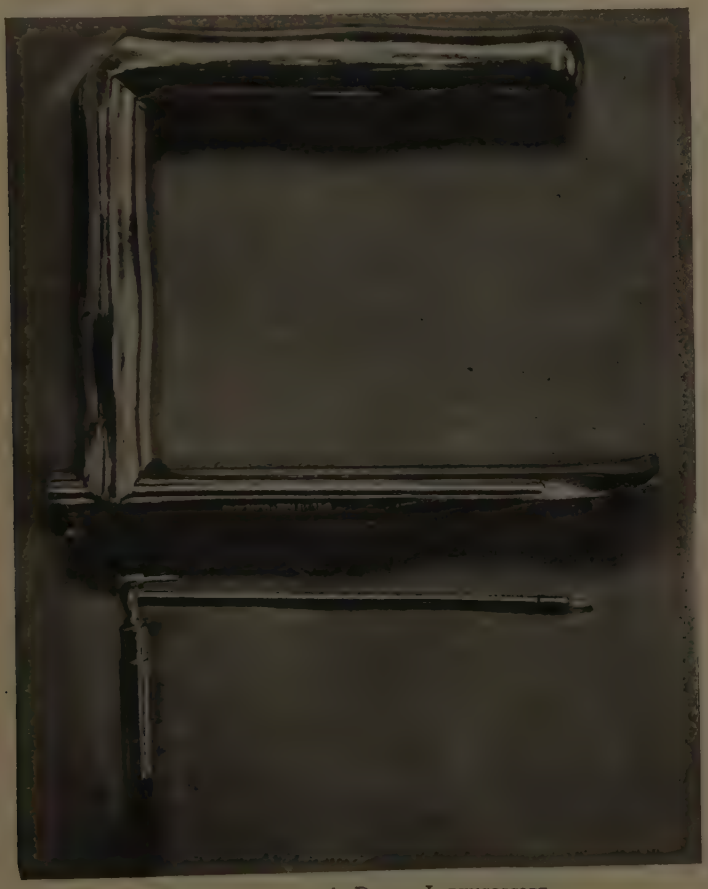

FIG. 155.—JACKSON'S DIRECT LARYNGOSCOPE.

tonsil, and laryngeal folds. In another of his cases macroglossia was evidently the cause; in a third an exact diagnosis was not established, but the condition was relieved by drawing the tongue well forward and fixing it to the lower lip.

The etiologic factors generally thought to be present in these cases are hypertrophy of the thymus, stenosing malformations of the larynx, congenital feebleness of the glottic muscles, and, in certain rare instances, cerebral lesions.

The Repair of Tracheal Wounds and Fistulæ.—Tiegel[10] conducted a number of animal experiments to determine the best method of suturing wounds of the trachea or bronchi. He advises the use of the Lem-

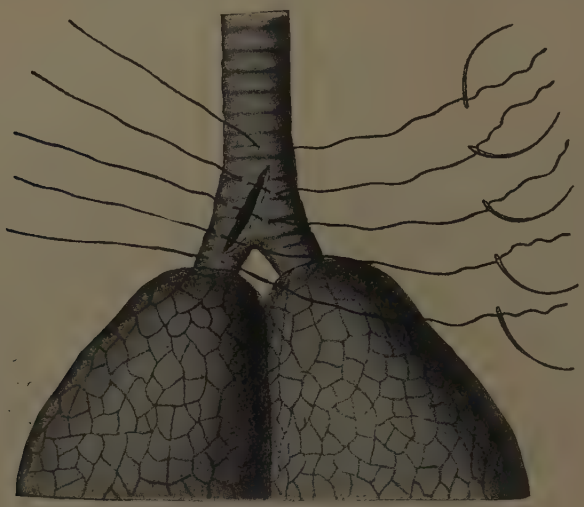

FIG. 156.—TIEGEL'S OPERATION. (Tiegel.)
Sutures in place.

bert suture, and when the lesion is located deep in the thorax, of grafting a piece of lung tissue over the line of suture (Figs. 156–158).

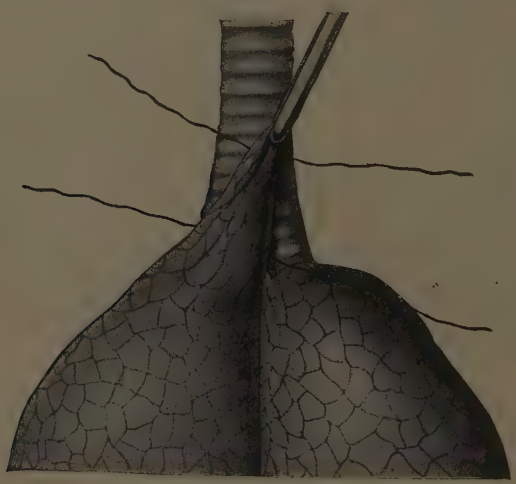

FIG. 157.—TIEGEL'S OPERATION. (Tiegel.)
Drawing the lung over line of suture.

Hohmeier[1] experimented with a view to determining the best tissue to employ for grafting, in the repair of loss of tissue in the tracheal wall. He advises aponeurosis, preferably dissected from the sterno-

mastoid sheath. This he places over the opening in the trachea and fixes by four through-and-through sutures at the four angles. Two other layers of suture are next introduced to insure firm fixation of the graft to the trachea.

FIG. 158.—TIEGEL'S OPERATION. (Tiegel.)
Graft sutured in place.

PROPERTY OF SURGICAL OFFICE
MAY BE REMOVED

The experiments were successful in dogs, the wounds healing kindly in from eight to ten days. (Figs. 158 and 159 show the graft sutured in place and the result after healing.)

Nowakowski repaired an extensive loss of tissue in the cervical portion of the trachea (the result of sloughing following repair of a cut-throat wound) by means of an osteocutaneous graft. He dissected an osteoplastic flap from the clavicle, the bone portion being a thin layer of cortex. This he placed over the tracheal opening, skin side inward, and sutured the cutaneous edge to the tracheal mucous membrane. The exposed bone was next covered by a second skin flap removed from the side of the neck. A tracheal cannula was left in the lower angle of the wound for several days. After a slow and somewhat complicated convalescence the patient recovered.

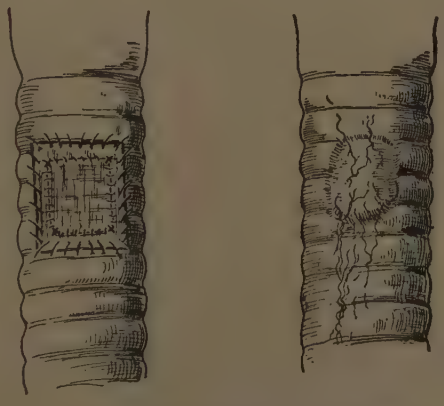

FIG. 159.—TRACHEAL GRAFT. (Hohmeier.)

Grey Turner, of Newcastle, reports the history of a case of extensive sloughing of the trachea following a cut-throat wound, in which he removed the diseased segment of trachea, including two rings, and

sutured the distal extremity to the cricoid. Although suppuration followed, the final result was satisfactory.

Tuberculosis of the Larynx.—Körner[2] reports the history of a case of successful removal of a tuberculoma by thyrotomy, in which the patient six months later was reported well. This author is of the opinion that these pseudoneoplasms are less active than other forms of laryngeal tuberculosis, and are, therefore, favorable cases for extirpation.

During the past two years I have operated on 2 cases of apparent neoplasm of the larynx, which on microscopic examination proved to be tuberculous. One was located in the ventricle, and appeared as an oval bean-shaped body covered by unbroken mucous membrane; the other was a pearly white papilloma of the vocal chord. Both were removed by laryngeal fissure with prompt operative recovery; but in the last a secondary operation was necessary for the removal of necrosed cartilage and a mass of granulation tissue causing marked stenosis.

Trichinosis of the Larynx.—MacKenty[4] reports 4 cases of laryngeal edema and stenosis resulting from trichinosis. The diagnosis was made by the occurrence of multiple myositis, edema of the face and eyelids, and the presence of a marked eosinophilia. In 3 of the 4 cases the percentage of eosinophiles was 48, 30, and 25.

Cancer of the Larynx.—The most important question in laryngeal surgery to-day is to determine the best method of treating cancer of the larynx.

As pointed out in Chapter XL., this disease is of frequent occurrence, its early diagnosis is easily possible by methods already described and urgently advocated, and the percentage of positive cures following successful early operations in the intrinsic variety is high, much higher, in fact, than in many other regions of the body. Thanks to the gradual appreciation of these facts by most modern intelligent practitioners, the surgeon is now called at a much earlier period than ten or fifteen years ago.

The old and wholly unreasonable prejudice entertained by certain practitioners and specialists, which induced them to believe that an individual might better be dead than living without a larynx, has been largely dissipated by the number of healthy and happy individuals now living who have been cured of laryngeal cancer by radical surgery.

If only practitioners would logically act upon their knowledge that early laryngeal cancer is curable, and investigate every case of suspicious unexplained hoarseness in a patient of the cancer age, it is my opinion that in a few years the end-results in the surgery of cancer of the larynx would be far in advance of those of malignant disease in any other organ or tissue of the body.

During the past four years a number of interesting statistical papers have been published, a review of which will give a fair idea of the present status of surgery in this important disease.

Sendziak collected 1002 cases of laryngeal cancer operated upon during a period of fifty years since the introduction of the laryngoscope.

A review of these cases, operated upon by a great variety of methods and by many operators, gives the following general results:

Endolaryngeal removal, 39 cases, 18 cures, or 46 per cent. Thyrotomy, 214 cases, 106 cures, or about 50 per cent. Partial laryngectomy, 171 cases, 39 cures, or 22.8 per cent. Total laryngectomy, 269 cases, 58 cures, or 21.6 per cent.

The high percentage of recoveries reported following endolaryngeal operations is probably due to faulty diagnosis in the early period, and to the fact that only the earliest and most limited growths were treated in this manner.

Thyrotomy undoubtedly gives the best results, for the reason that it is applicable only to early cases of intrinsic cancer, and the operation being directly under guidance of the eye and sense of touch of the operator, thorough removal is the rule.

Chiari, in his address delivered before the American Laryngological, Rhinological, and Otological Society in 1909, gives statistics of total extirpation collected by him from 1895 to 1908:

Total number of operations, 242. Operative deaths, 29, or 12 per cent. Relative cures, 24, or 9.9 per cent.; definite cures, 38, or 15.7 per cent. The operative mortality of total laryngectomy during this period is actually lower than that of partial laryngectomy.

Koschier,[3] the same year, reports a personal series of 14 recent operations for cancer without mortality, together with a report of a previous series, making a total of 28 cases. Of 18 patients operated upon more than three years ago, 8 were free from recurrence, showing a radical cure in 44 per cent. Of these 18 cases, 5 were by thyrotomy, with 4 cures; 10 partial laryngectomy, with 2 cures; 3 total laryngectomy, with 2 cures.

Schmiegelow[7] in 1910 reports 48 personal operations for laryngeal carcinoma. Of these there were 5 operated upon by the endolaryngeal method, 2 reported well at the end of one year, the 3 others had recurrences, one as late as seven years after the operation; 20 were treated by thyrotomy, with 4 deaths and 9 cures, 1 other recovering after a secondary laryngectomy; 4 cases of partial laryngectomy, all fatal; 5 cases of total laryngectomy, one definite cure (twelve years); 2 operative deaths from pneumonia, and 2 later deaths from recurrence.

Gluck in 1908 reported 128 total laryngectomies, with 20 free from recurrence at the end of three years. Regarding his operative mortality, Chiari states that it was 13 per cent. for his entire series, including complicated cases. In uncomplicated laryngectomies he has had no mortality for several years.

The end-results reported by these authorities are unquestionably better than any previously published. In 1909 I reviewed the subject and collected the then available data regarding permanent cures following laryngectomy, which were estimated to be about 15 per cent., while the three-year cures in these later reports will average something over 20 per cent.

In my own limited experience the end-results in total laryngectomy

have been more satisfactory than in the operative treatment of cancer in any other organ. Of 6 total laryngectomies which survived operation performed more than three years ago, 4 are still living and free from recurrence.

Regarding the technic of total laryngectomy, I still recommend the method of Gluck, described in Vol. III., p. 506, for the reason that it has furnished the largest percentage of operative cures.

In a communication read before the New York Academy of Medicine, Section of Laryngology, in 1908, I described a slight modification of Gluck's technic, which in my hands has given better results. This modification consists in firmly affixing the trachea to the adjacent tissues by a preliminary tracheotomy and packing with iodoform gauze on either side of the tube. This is done ten or twelve days before the laryngectomy and results in a firm inflammatory induration in and about the peritracheal tissues, which furnishes an excellent barrier against the downward spread of infection to the lower cellular planes of the neck and mediastinum. At the time of the final operation the trachea is divided below the cricoid, the mucous membrane destroyed, and its lumen occluded by two mattrass sutures above the cannula, or firmly packed with iodoform gauze to prevent the entrance of wound fluids.

Gluck's method of lifting the trachea from its bed and stitching it to the skin, while it undoubtedly prevents to a large extent wound fluids entering the trachea, opens up the peritracheal cellular space and thereby favors the descent of infection to the mediastinum.

Ricardo, Botey, Sébileau, and Cisneros advise anterior fixation of the divided trachea to the skin, but do this at a preliminary operation, postponing the laryngectomy until firm adhesions have fixed the trachea in its new position.

Koschier, who next to Gluck has apparently obtained the best operative results, advises a two-stage operation, but prefers leaving the trachea in its normal position, and depends upon tamponade to prevent the entrance of wound secretions into the trachea.

During the past year Sébileau[8] presented an instructive communication to the Société de Chirurgie of Paris. In it he stated that the two great dangers attending total laryngectomy were the aspiration of infected wound secretions into the trachea, giving rise to what he terms *bronchopulmonary septicemia;* and infection of the deep cellular planes of the neck, giving rise to *lymphovenous septicemia.* The reason for the frequency of the latter complication is the presence of a dead space created by removal of the larynx which it is difficult to obliterate, and which is easily infected by the slightest leakage of pharyngeal secretions through the sutured pharyngeal wound.

To avoid these dangers he advises, first, a preliminary tracheotomy twenty days before the final operation; second, accurate suture of trachea stump to the skin just above the sternum, anchoring it firmly in place by including in at least two of the sutures the sternal portion of the tendon of the sternomastoid muscle; third, firm closure of the pharyngeal wound, reinforced by fixation of the hyoid muscles in front of the line

of suture; fourth, obliteration of the dead space by drawing together in front of the esophagus the severed hyoid muscles and subcutaneous fatty tissue, and the use of a firm compression bandage; fifth, drainage of the upper angle of the wound to establish a remote outlet for pharyngeal secretions in the event of leakage; sixth, the use of Gluck's nasal feeding-tube for eight or ten days after operation; and seventh, frequent dressings to keep up compression and to favor solid primary healing of the tissues between the pharyngeal wound and the tracheal stump.

In the technic of the operation this author advises two horizontal incisions from the lower as well as the upper extremity of the longitudinal cut. This allows the turning outward of two lateral flaps to the border of the sternomastoid muscles, facilitates exposure of the larynx and trachea, permits free dissection of the lymphatic structures, and firm fixation of the tracheal stump to the sternomastoid attachments. The surgical principles laid down in this interesting paper are practically identical with those stated by myself in my paper published in 1909.

If one will bear in mind the two great sources of danger in these operations, and can contrive to accomplish what Sébileau aims to accomplish by the technic he describes, namely, obliteration of the dead space created by the removal of the larynx, and the prevention of wound secretions entering the trachea, it matters little what particular technic is followed.

The great success of Gluck with his technic shows conclusively that he accomplishes these two results, and in his hands, at least, the method leaves little to be desired.

Regarding the anesthetic to be employed in these operations, most European authorities (including Gluck) strongly recommend chloroform. I have employed both ether and chloroform in my laryngeal work, and am convinced that chloroform possesses many advantages. Although the immediate mortality from the anesthetic may be slightly higher after the administration of chloroform, the diminished tracheal irritation and bronchorrhea and the lessened postoperative vomiting greatly outweigh this disadvantage.

Pochammer recently reported a successful laryngectomy with removal of a substernal cystic adenoma of an accessory thyroid under local anesthesia. In this case he employed novocain and adrenalin. The operation was free from pain and presented no great difficulties. The patient was reported entirely well in six weeks.

In Vol. III. I referred to a number of complicated operations successfully performed by Gluck. These included cases of laryngopharyngeal carcinoma, often with extensive lymph-node metastasis, and necessitated, in addition to the laryngectomy, extensive dissection of the neck with ligation of the larger blood-vessels, removal of large areas of the pharyngeal wall, and esophagus. I saw a number of patients in Gluck's clinic who had recovered from these grave operative procedures.

Zimmermann[11] in January last reported 2 such cases with operative recovery. One in which he removed the larynx, five rings of the trachea,

7 cm. of the esophagus, and a number of deep-seated lymph-nodes. The open upper extremities of the trachea and esophagus were sutured to the skin. In the second case he resected the larynx, three rings of the trachea, and 6 cm. of the esophagus for sarcoma. In this case also the upper extremity of the esophagus was fixed to the skin to the right end just above the tracheal opening. Both patients made good operative recoveries. The first died, however, of a rapid recurrence less than two months after operation, and the second by the accidental removal of the tracheal cannula, which could not be replaced in time to prevent asphyxiation, three months after his recovery from the operation.

New Growths of the Trachea.—A number of successful cases of operation for the removal of benign and malignant tumors of the trachea have been reported since the publication of Vol. III. of this work, which give considerable encouragement to those who favor radical operation in these cases. One case in particular, reported by Schmiegelow,[6] illustrates the feeble malignancy in certain carcinomata of the trachea. A woman fifty-four years of age suffered from progressively increasing dyspnea, thought to be due to a gumma of the trachea. Tracheotomy and antisyphilitic treatment for six weeks without improvement. Then a wide opening of the trachea and cricoid with curetage of the tumor mass. Microscopic examination revealed the fact that the tumor was an alveolar carcinoma. Recurrence one year later treated by complete resection of the trachea for a distance of $5\frac{1}{2}$ cm., with sutures of the distal extremity to cricoid. This patient made a satisfactory operative recovery and was reported well six years later.

Reich[5] in 1910 reported an exceedingly rare tracheal tumor situated in the submucous tissue of the trachea just below the cricoid, which was pushed upward into the larynx with each expiratory effort. This was easily removed by cricotracheotomy, and proved, on microscopic examination, to be an isolated island of tissue showing amyloid degeneration. The author, after careful review of the literature, was able to find only 14 similar observations, 12 of which were reported as growing from the laryngeal mucous membrane and 2 from the trachea.

Numerous cases of obstructing tracheal struma have been reported by Hoffman, Brentano, and others, as pointed out in Chapter XL. These have a potential malignancy and should be removed at an early period.

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CHAPTER CXVI.

SURGERY OF THE THORAX.*

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New York.

In the four years which have elapsed since the publication of Vol. III. of this work much also has been added to our knowledge regarding the possibilities of thoracic surgery. In perhaps no other department has there been expended so much intelligent thought, accurate experimental investigation, and conscientious search after better and safer operative methods; and yet, when one reviews the entire field of this praiseworthy and painstaking work, the net result is somewhat disappointing.

A review of the literature of the subject of thoracic surgery for the past few years will show that there has been no great achievement, no epoch-making discovery, no conspicuous advance in the therapeutics of thoracic disease, but rather a steady progress in perfecting diagnostic methods and a gradual advance in the success of operative procedures already well known and established in 1908.

The most important advances that have been made are in the treatment of penetrating wounds, injuries of the lung, empyema, new growths, tuberculosis, in perfecting the various differential pressure appliances, and the introduction of intratracheal insufflation anesthesia.

Among some of the other advances may be mentioned improved methods of treating abscess of the lung, gangrene, bronchiectasis, mediastinal growths; and the technic of pneumectomy and transpleural gastrectomy.

Two or three conditions not mentioned in Chapter XLI. will be considered, after which the subjects in which important advances have been made will be taken up in the order in which they were considered in that chapter.

Creaking Scapula (" *Cracquements Sous Scapularies* ").—This is a condition in which the normal movements of the scapula over the chest wall are accompanied by a distinct crepitus or grating, easily appreciated by the patient and often heard by near-by individuals. In certain instances the sound can be heard at a distance of several feet. The condition, while rarely painful, is a source of annoyance, and may result in impaired function. The condition has been studied by Huguier,[12] Le Dentu, and others, who find that it is due to a variety of causes. One of the commonest etiologic factors is the presence of a

* Supplementary to Chapter XLI., Vol. III., p. 512.

small osteoma or osteochondroma on the ventral surface of the scapula, most frequently near the inferior or superior angle. This by constant friction causes atrophy of the muscles and a more or less direct contact of the growth with the ribs. In other instances a bursa may be found, the walls of which have become partly fibrous or cartilaginous, and which not infrequently contains seed-like bodies. In rare instances only muscular atrophy is present.

In the treatment of this condition, rest, massage, and counter-irritation are of no avail. Surgical removal of the growth or bursa is indicated, and is best accomplished by an incision between the vertebral border of the scapula and the spine, division of the trapezius and rhomboid fibers, raising the scapula, and removal of the growth or bursa. When there is evident atrophy of muscle, Mauclaire and Huguier advise the interposition of a muscular plane from the trapezius or rhomboid muscles. The incision is then united by layer suture, and the arm kept at rest until complete healing of the wound.

Pulmonary Emphysema.—Freund, of Berlin, has recently emphasized the importance of rigidity of the chest wall as a causative factor in the respiratory embarrassment in certain cases of alveolar emphysema. His investigations also revealed the fact that this rigidity was in a large part caused by a calcification of the costal cartilages, resulting in a decided diminution in their normal elasticity. These changes were noticed more particularly in the second, third, and fourth cartilages, and more often on the right side; but later observation has shown that the condition is often bilateral and may be present in any or all of these structures.

Freund advised resection of these calcified cartilages, with a view to allowing greater freedom in the respiratory movements. The early successes which followed the first operations of Hildebrand, Haasler, and other German surgeons has led to considerable activity in this field. In many of the earlier cases the resections were subperichondrial, and as a result a regeneration of cartilage took place which caused a gradual diminution in the freedom of movement first produced by the operation, and a return of symptoms.

At present the technic generally advised is to remove not only the cartilages, but also the perichondrium, or, as advised by Hoffmann, remove at least 4 cm. of the cartilage, preserve the anterior and posterior layers of the perichondrium, divide this and suture it over the cut ends of bone or cartilage to prevent reunion.

During the past two or three years many successful cases have been reported, notably 2 by Tuffier, in one of which he removed the first six cartilages on the right side, and in the other all the cartilages on both sides. Both of these patients were extensively disabled and unable to work. In both the result was a return to health and earning capacity.

During the past year Hirschberg[9] has advised for this condition a transverse division of the sternum between the junction of the second and third cartilages with this bone. He calls attention to the fact that Braun had demonstrated that this operation increased the capacity of

the thorax from 400 to 500 c.c., and reports the case of a child twelve years of age cured by this procedure after failure by resection of the fifth, sixth, and seventh ribs. It is only fair to state, however, that the resection failed to remove the perichondrium, and that the rib resection gave temporary relief. Gottstein, Stich, Hoffmann, and Vander Velden have recently reported cases of Freund's operation with marked success. While the operation can have no effect on the already diseased lung tissue, there is at present sufficient evidence to prove that the increased movements of the thorax brought about by these operations often gives a large measure of relief; and as the operative risk is inconsiderable, these procedures are to be recommended in selected cases.

From the favorable reports of cases which have appeared in recent current surgical literature, it is probable that the minor procedure, or removal of the costal cartilages with removal or destruction of the perichondrium, will give relief in the majority of cases and should be the operation of choice.

Foreign Bodies in the Bronchi.—As stated in Volume III., prior to 1897 foreign bodies lodged in the bronchi were generally regarded as beyond the possibility of surgical relief, for the reason that practically all attempts at removal by a transthoracic operation had proved fatal. After the successful employment of bronchoscopy by Killian in that year, and the demonstration by that surgeon that foreign bodies could be removed even when located as far as the second division of the bronchus, the method of extraction by bronchoscopy, as described in Chapter XL., has been almost universally employed in these conditions.

It occasionally happens, however, that the method is unsuccessful, and in these cases the transthoracic operation is still to be considered.

In a series of animal experiments by Davidson, of Breslau, with a view to determining the best method of approaching, opening, and suturing the bronchus, that surgeon advises exposure of the lung by a large posterior opening, recognizing the bronchus by sense of touch, stripping away the lung tissue by blunt dissection, and after opening the bronchus to close the incision by fine silk sutures placed close together, including the cartilage and peribronchial tissues; after which the line of suture is covered with pleura which is secured to the surrounding tissue by an additional suture. He calls attention to the necessity of absolute hemostasis, and advises closure of the pleural cavity without drainage.

With our present facilities for differential pressure and improved technic, it is probable that the transpleural operation can be employed with less risk than in the past.

Tiegel[20] also reported some experimental studies in bronchial suture. He condemns perforating sutures, and advises closure of the wound in the bronchus with Lembert sutures, with the application of a lung graft when practicable over the sutured area.

Penetrating Wounds of the Chest.—Since 1908 considerable attention has been centered upon the treatment of penetrating wounds

of the chest, and a large number of articles have appeared, giving statistics from many of the larger European clinics. These writers may be divided into two schools: those who favor immediate surgical intervention in the majority of penetrating wounds, and those who advise expectant treatment in all cases excepting those with evidences of grave or progressive hemorrhage, or where marked contamination of the pleura is known to have taken place.

Among the former may be mentioned Zeidler, Lavroff, Baudet, and Stuckey; among the latter, Lucas-Championnière, Holmberg, and Bomhard are perhaps the most conservative.

Those who advocate immediate intervention in all penetrating wounds argue that preoperative diagnosis is difficult and often wholly impossible, for the early symptoms and signs give one no idea of the extent or importance of the intrathoracic damage.

Thus Lavroff[13] reports 121 cases of stab-wounds, where on exploration he found 55 wounds of the diaphragm, 48 wounds of the lung, 12 wounds of the heart, 2 of the pericardium, 9 of the parietal blood-vessels, and 3 of the mediastinum. In many of the cases the visceral injuries were multiple. This same author quotes Zeidler, who insists that in stab-wounds involving the heart the signs are particularly unreliable and misleading, 28 per cent. of those observed by him were discovered only by operation.

This author speaks of the "heart zone": A space limited above by the second rib, externally by a line from the junction of this rib with the anterior axillary line to the seventh intercostal space on the nipple line. In his experience all wounds of the heart enter the chest within this space.

Lavroff also calls attention to the unreliability of signs, in concealed hemorrhage from wounds of the parietal blood-vessels, and in injuries of the diaphragm. The latter injury furnishes not only a large number of immediate fatalities from infection of the peritoneum; from shock and intestinal obstruction from hernia through the diaphragmatic opening; from injury to the stomach, liver, or other abdominal viscera, but also from the later effects of hernia of the stomach or intestine through the unrepaired wounds in the diaphragm.

Many such cases have been reported during the past two years by Weiss, Gautier, du Seutre, and others. Weiss particularly calls attention to the fact that in transpleural wounds of the diaphragm large hernias of hollow abdominal viscera occur quickly even through comparatively small openings. This he explains by aspiration of the viscera into the pleural cavity on account of the negative pressure within the chest, which has not been wholly overcome by the entrance of air through the thoracic wound. In many of these cases of stab-wounds the parietal wound was small and quickly closed after withdrawal of the cutting instrument, allowing little or no air to enter the pleural cavity.

Mogoula reports a case where the cutaneous wound measured 5 cm., while the diaphragmatic wound was 15 cm. in length. This

author also states that all wounds below the fourth space may involve the diaphragm.

Another reason for early surgical intervention in these cases is the rapidity of recovery after operative treatment. Zeidler reports the average duration of hospital treatment of operative cases as forty-seven days, while in the non-operative cases it was eighty-five days.

Grassmann[7] calls attention to the statistics of Garrè, published in 1905; giving 700 cases of wounds and injuries of the lung treated conservatively with a total mortality of 40 per cent., which in the cases of subcutaneous rupture was 50 per cent. He expresses the belief that most cases should have the benefit of an immediate operation. The object of the operation should be to repair the wound in the lung, to arrest hemorrhage, to evacuate clots, to remove foreign bodies, and to close the pleura if not too badly infected.

While the reasoning of the interventionists is apparently sound and their operative indications the result of logical deduction, the statistical evidence is not always as convincing. Thus Lavroff quotes the results of a series of 257 cases occurring in Zeidler's clinic during a period of five years. Of these, 155 cases operated upon gave a mortality of 36.7 per cent., while in 102 treated conservatively the mortality was only 14.7 per cent. The author attempts to explain the fact by stating that the non-operative cases were far less severe in character. Mogoula[16] reports a series of 61 cases involving wounds of the diaphragm operated upon with a mortality of 37 per cent., many of the cases being complicated by wounds of other thoracic and abdominal viscera. This he contrasts with a similar series of 33 non-operative cases of Frey, with 29 deaths, or a mortality of 87 per cent.

Holmberg,[10] on the other hand, reports a series of 324 cases, of which 266 were stab-wounds, 39 gunshot-wounds, and 19 closed or subparietal injuries. All but 4 of these were treated conservatively, that is, the stab-wounds were carefully disinfected and sutured; the gunshot-wounds were cleaned and an aseptic dressing applied, and the closed injuries were treated expectantly.

The total mortality in this series in injuries involving the lung or pleura was only 15.8 per cent., of which the largest series, that is, the stab-wounds, showed 8.1 per cent.; the gunshot injuries, 37 per cent.; and the closed ruptures, 47 per cent.

These statistics are certainly remarkable and contrast rather strikingly with the larger series reported several years ago by Garrè, in which similar conservative measures were employed.

The reason for this low mortality is evidently the favorable results obtained in the larger series of stab-wounds, as in the other classes the mortality percentage approached more nearly that reported from other clinics.

In an interesting communication to the last International Congress of Surgeons at Brussels (1911), Lenormant discusses at length the treatment of wounds of the lung. In it he calls attention to the fact that on account of the marked retraction of the lung which takes

place when the pleural cavity is opened, and the comparatively low blood-pressure in the pulmonary vessels,* hemorrhages from wounds in these highly vascular organs have a strong tendency to cease spontaneously unless one of the larger trunks is opened. He also refers to the experimental researches of Talke, who demonstrated that in wounds of the lung there was a strong tendency to spontaneous and rapid primary healing. For these reasons he strongly favors conservatism in the treatment of these cases. He describes two grave conditions, however, which may occur in these injuries: first, *pneumothorax à soupape*, valvular pneumothorax, or pneumothorax under tension, a condition in which air is pumped into the pleura with each respiratory act, but in which no air escapes. This very quickly results in great intrapleural pressure with dislocation of the heart and other mediastinal structures, giving rise to grave dyspnea; second, mediastinal emphysema from subpleural rupture. This also increases with respiration, and may cause great pressure on the heart, superior vena cava, and other structures, which, in turn, gives rise to marked circulatory disturbances, evidenced by dyspnea, extreme cardiac weakness, cyanosis of the face, and dilatation of the superficial veins of the neck. In one case operated upon by Sauerbruch for this condition he found the superior vena cava dilated to the size of a child's arm.

For the first of these conditions Lenormant advises aspiration of the air, which often gives prompt relief to the dyspnea. If the symptoms recur, he advises making a large opening into the pleura, which converts the *pneumothorax à soupape* into an ordinary open pneumothorax. This opening is maintained by a large rubber drainage-tube, or one of the methods of aspiration drainage (to be described later) can be employed. For mediastinal emphysema with grave symptoms he advises making an incision at the base of the neck just above the sternum, opening up the cellular space of the anterior mediastinum with the finger or some blunt instrument, and then applying a Bier cup with strong negative pressure. This, in the experience of Tiegel, has resulted in marked relief, large bubbles of air escaping into the cup with a moderate amount of bloody serum. Sauerbruch obtains the same effect by the use of the negative pressure cabinet after cutaneous incisions in the neighborhood of the mediastinum.

Regarding the treatment of grave intrapleural hemorrhage, Lenormant is of the opinion that death more frequently results from asphyxia from pressure on the heart and mediastinal structures than from the actual loss of blood. To avoid this danger, as in the cases of pneumothorax under pressure, aspiration of a part of the blood will often give relief. This, however, should, if possible, be delayed until the danger of causing fresh hemorrhage has passed.

In cases of severe inundating pleural hemorrhage, with or without hemoptysis and external bleeding, the author doubts the value of surgical intervention, for the reason that the wound is generally of one of the

* The pressure in the aorta is nearly three times greater than in the pulmonary artery (Chauveau and Faivre).

large vessels at the root of the lung and often associated with damage to a bronchus. In less violent, but progressive hemorrhages, threatening the life of the individual, he advises thoracotomy by a large incision, thorough exploration of the lung, repair of the pulmonary wound, removal of the clots, and closure without drainage.

A critical review of these reports will reveal the fact that there is in reality less radical difference of opinion than at first appears, for all experienced surgeons advise operation in cases of severe and progressive hemorrhage in wounds of the heart or diaphragm, and where there is known to be marked septic infection; and while the interventionists would advise exploratory operation in all cases of penetrating stab- or gunshot-wounds, experience has abundantly proved that a large proportion of these, without symptoms and physical signs of progressive hemorrhage or grave visceral injury, recover promptly. As pointed out in Chapter XLI., this is particularly true in perforating gunshot-wounds made with the modern high-velocity small-caliber weapons.

My own personal experience would lead me to advise immediate exploratory thoracotomy in all cases of penetrating wounds of the chest which presented signs of hemorrhage threatening the life of the individual or seriously embarrassing respiration; in all cases where there is reason to suspect injury of the diaphragm, heart, or other important structures; and in all cases of large pleural wounds where there is evident septic contamination and an open pneumothorax. I would advise careful disinfection and aseptic dressings in penetrating gunshot-wounds without symptoms or signs of a more grave injury, and in simple stab-wounds without evidence of grave hemorrhage, pneumothorax, or injury to diaphragm or heart.

In all cases of doubt in wounds of the heart zone or in the region of possible diaphragmatic injury, I would favor exploratory operation as the safest method of treatment.

Traumatic Rupture of the Azygos Vein.—Stenbeck, of Stockholm, has recently reported a case of sudden death from rupture of the lesser azygos vein as a result of a severe contusion of the chest wall. The autopsy in this case showed extensive hemorrhage into the mediastinal tissues and left pleural cavity.

Acute Osteomyelitis of Ribs.—Fritz has recently called attention to the fact that in acute septic osteomyelitis of the ribs, it is possible for the subperiosteal abscess to consist of two pouches—one extrathoracic and one intrathoracic. He urges in these cases thorough operation, removal of necrotic bone, and drainage of both pouches. He also calls attention to the fact that infection of the pleura secondary to acute osteomyelitis of the rib is rare, having occurred only once in his series of 75 cases.

Progressive Necrosis of the Costal Cartilages.—Röpke describes under this title a secondary infection of the cartilages of the ribs due to typhoid fever, influenza, or other systemic infections. He states that it occurs most frequently in the sixth, seventh, and eighth cartilage, rarely above the fifth or below the ninth. The disease causes a slowly

progressive but extensive necrosis of these structures; and in order to effect a cure it is necessary to expose the entire area and to remove the cartilages well beyond the gross evidences of disease.

I have encountered 3 examples of this disease. In each of these two or more operations were necessary to bring about complete healing, for the reason that only that portion of the cartilage was removed at the primary operation which appeared to the naked eye to be diseased; and it was only at the second or third operation that the cartilage removal was sufficient to bring about a cure. In one of these cases the lesion was in the first and second cartilages on the left side. Although Keen in 1898 called attention to typhoid infection of the costal cartilages, the fact that other varieties of infection occurring in these structures pursued a like obstinate course has not been generally recognized.

Tumors of the Ribs and Costal Cartilages.—In May, 1910, Tuffier presented to the Société de Chirurgie, Paris, a man twenty-one years of age from whom he had removed an enormous osteosarcoma involving the upper four ribs, a part of the clavicle, the axillary artery and vein, and the surrounding muscles. At the time the patient was exhibited to the Société, ten months after operation, the man was in perfect health and able to work.

Huguier,[1] in a recent article, strongly indorses the advice of Quénu and Longuet, that all chondromata of the bony or cartilaginous thorax should be removed by a radical operation, including all the tissues of the chest wall, for the reason that all of these tumors have a potential malignancy. The mortality of the intrapleural operation under differential pressure is but slightly higher than the extrapleural resection, and the remote results are much more favorable.

Huguier reports a successful case of extensive intrapleural resection for chondroma, including the seventh and eighth ribs. At the close of the operation the wound was united without drainage and the air removed from the chest-cavity by aspiration. He strongly advises against drainage in all non-infected lesions of the thoracic cavity.

An exceedingly vascular sarcoma of the rib was reported by Võino-Iassenetzky, which resembled, and at operation was thought to be, an aneurysm of the intercostal artery. When the specimen was examined microscopically, however, it was found to be a cavernous sarcoma.

These rare tumors occasionally have been described in the long bones as aneurysms of bone, endothelioma, pulsating sarcoma, etc., and are extremely malignant.

Pneumothorax.—The treatment of operative pneumothorax will be taken up in a later section, in which a description of the modern appliances for differential pressure will be considered.

Hydrothorax.—The treatment of rebellious cases of hydrothorax by thoracotomy and drainage was mentioned in Vol. III. of this work. Recently this method has been again advocated by Lionel Stretton in a communication which appeared in the Practitioner for February, 1911. The great danger of infection in drainage of the pleural sac would seem

to me to be a strong contraindication to this method of treating an uninfected serous effusion.

Pyothorax (*Empyema*).—During the past four years little or nothing has been added to our knowledge of the pathology or symptomatology of this condition, but many valuable suggestions have been made regarding treatment.

One of the most radical departures from the classical methods of treating this disease is the plan advocated by Murphy, of substituting for thoracotomy and drainage, aspiration of the pus, and the injection into the pleural cavity of from 20 to 60 c.c. of a 2 per cent. mixture of formalin and glycerin. Following the first injection the fluid quickly returns. After an interval of three or four days it again should be removed by aspiration if the fluid causes much dyspnea. The formalin mixture should then be repeated once in ten to fourteen days while the fluid remains purulent. After the third or fourth treatment (sometimes earlier) the fluid will begin to lose its purulent character and gradually assumes the appearance of clear or slightly reddish, cloudy serum. At this stage, or when fluid can be demonstrated to be sterile, the injections are discontinued and the innocuous fluid is gradually absorbed. The formalin mixture should be at least twenty-four hours old before using. The needle should be inserted through the chest wall obliquely, never direct. It is Murphy's idea that the formalin sterilizes the fluid and sac, stimulates the production of polymorphonuclear cells, which favors disintegration and absorption of the solid exudate, and causes cicatrization and contraction of the granulation tissue. Murphy states that all empyemas which do not connect with a bronchus or one of the hollow abdominal viscera may be cured by this method.

I have employed this method in 4 cases at the Roosevelt Hospital, and I know of a number of instances where it has been employed in other New York hospitals. In some of these cases the result was unsatisfactory, possibly due to faulty technic, and the patients subsequently had to be drained. F. T. Billings has recently reported 7 cases treated by the method, with 3 deaths, in 1 of which death was due to causes other than the treatment.

One of the most valuable therapeutic suggestions which has appeared is that of Beck, of Chicago, who advocates the treatment of chronic empyema sinuses by the injection of bismuth paste. Ochsner has recently reported a series of 14 old and exceedingly rebellious cases successfully treated by this method. Many of these cases had submitted to two or more operations, including more or less extensive thoracoplasties, without benefit. As a result of these injections, Ochsner reports a marked improvement in the septic symptoms when present, a gradual diminution in the discharge, and a rapid cleansing of the cavity. Favorable reports have also been published by Ferguson and a number of other surgeons.

At the Roosevelt Hospital the method has been successfully employed in a number of instances during the past year. The plan is to inject the sinus every second or third day with the paste until the suppuration has almost disappeared, then less frequently until the sinus is closed.

Ochsner employs two mixtures:

No. 1 is made up of one part of arsenic-free subnitrate of bismuth in 2 parts of sterile vaselin.

No. 2 is made of 30 parts of bismuth, 60 of vaselin, and 10 of paraffin.

No. 1 is used in the beginning of treatment, and until the discharge has been reduced to a small amount; after which No. 2 is substituted.

At the Roosevelt Hospital a number of sinuses have closed permanently after one injection. This, in my opinion, is one of the most valuable contributions to the therapeutics of empyema which has appeared in many years.

Aspiration Drainage.—With a view to preventing the formation of a dense unyielding exudate on the visceral pleura, interfering with sub-

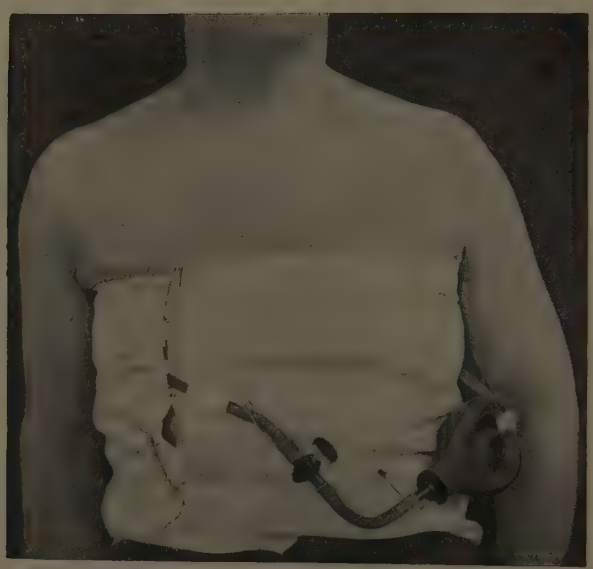

FIG. 160.—BRYANT'S EMPYEMA DRAINAGE. (Brewer.)

sequent expansion of the lung, several devices were mentioned in Vol. III. of this work, such as the frequent removal of the air from the pleural cavity after thoracotomy by means of an inverted glass funnel and aspirator, the use of the pneumatic cabinet, and elevating the intratracheal pressure by blowing water from one Wolff bottle to another.

A number of plans have recently been proposed to apply more or less continuous aspiration drainage in these cases from the time of operation. These plans have the advantage over those mentioned in Vol. III. in that they exert continuous suction, and can be employed at an early period after operation before the dense fibrinous envelope has had time to form and become organized.

One of the cleverest of these devices was that proposed by Bryant,

who passed the drainage-tube to the bottom of the pus-cavity, rendered the thoracic opening air-tight about the tube, and attached an ordinary Politzer bag to its distal extremity. When the bag is collapsed and attached to the drainage-tube, continuous suction is exerted, which keeps the cavity emptied and favors expansion of the lung. A stop-cock is placed on the drainage-tube proximal to the attachment of the bag. This allows the bag to be removed and emptied without admitting air to the pleural cavity. Haartel devised a similar but slightly more complicated apparatus for the same purpose, and reports favorable results. Both of these methods may be employed in ambulant cases.

FIGS. 161, 162.—BREWER'S EMPYEMA DRAINAGE-TUBE.

During the past two or three years I have employed aspiration drainage in practically all cases of empyema occurring in my service at the Roosevelt Hospital. The drainage-tube is a modification of the Wilson spool, as shown in Figs. 161, 162. The flange, fixed to the tube, is inserted into the thoracic cavity and the sliding flange pressed firmly down to the outer surface of the chest wall. This is held in place by a number of strips of adhesive plaster (Fig. 163) which render the joint air-tight. The distal end of the tube is next connected with the drainage bottle attached to the side bar of the bed, and it in turn with the upper of a pair of Wolff bottles. By siphon action the water from the upper Wolff bottle is conveyed to the lower, creating a vacuum which causes continuous suction and complete emptying of the pus-cavity (Fig. 165). After the amount of daily discharge has been reduced to a few drams, the tube is removed and a large Bier chest cupping-glass

applied several times a day, with sufficient negative pressure to bring the lung well down to the chest opening. This insures complete emptying of the cavity and frequent expansion of the lung, preventing thereby the formation of a dense unyielding exudate on the visceral pleura (Fig. 166).

By this method of treatment it has been found that the duration of postoperative treatment has been reduced, and the sinuses have closed

FIG. 163.—BREWER'S EMPYEMA DRAINAGE-TUBE IN PLACE, HELD BY ADHESIVE PLASTER.

more promptly. In 10 cases treated by this method there were no deaths, and the average duration of hospital treatment was thirty-nine days. In an analysis of 10 consecutive cases treated by the ordinary methods of drainage there was 1 death, and the average stay in the hospital was forty-five days. In the first series only 1 left the hospital with an open sinus; in the second, 4 had open sinuses at the time of discharge.

In those discouraging cases of a chronic sinus leading to a large dead space, caused by complete contraction of the lung and the presence of an unyielding fibrinous exudate on the entire visceral pleura, decortication (as described in Chapter XLI.) will prove satisfactory in many cases. Ransohoff has suggested for this condition not removal of the thickened pleura, but the making of multiple incisions down to the lung tissue. This gridironing of the thickened pleura, in his experience, will often result in complete expansion of the lung.

Ferguson, on the other hand, is an advocate, in these exceedingly chronic cases, of a far more radical operation than that of Fowler or Ransohoff, namely, complete *visceral pleurectomy*. His method is to

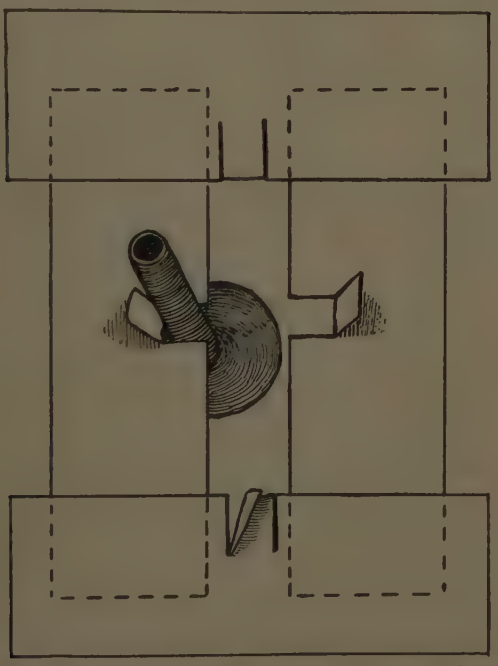

Fig. 164.—Diagram Showing Application of Adhesive Straps.

expose the contracted lung by a longitudinal midaxillary incision, or one branching off from the original thoracotomy wound. He next liberates the apex of the lung by dissecting it free from the cervical dome, cutting, if necessary, into the healthy lung tissue. The entire visceral pleura is then dissected from the lung by scalpel or scissors, especial care being taken to remove any excess of exudate at the junction of the visceral and parietal pleuras. The overhanging rib stumps are sufficiently removed to allow easy approximation of the musculocutaneous flap to the surface of the now expanded lung, and this flap is sutured in place with liberal drainage.

Ferguson[2] is of the opinion that this radical procedure may be relied upon to cure many of these obstinate and rebellious cases. He freely

admits the probability of severe shock, and advocates a two-stage operation when necessary. He also calls attention to the fact that a too rapid expansion of the liberated lung may cause operative embarrass-

Fig. 165.—Syphon Drainage: Wolff Bottles in Place.

ment, and advises gauze compression over the exposed surface before complete expansion has occurred.

Dowd recommends a somewhat similar but far less formidable operation in the old unexpanded lungs following thoracotomy in children, and exhibited a number of successful results at a recent meeting

of the New York Surgical Society. He made the observation that in many of these cases in children the dead space would be found to extend upward and forward from the thoracotomy wound; and that a more or less severe type of scoliosis was apt to develop if the disease was of long standing. His operation consisted in making a cutaneous incision upward and forward from the original wound, laying bare the ribs to the upper extremity of the dead space; freely exposing this space by the removal of portions of several ribs, generally making a triangular wound; then, by decortication of the exposed lung surface, to allow sufficient expansion to fill the cavity. The removal of segments of the overlying ribs allowed sufficient contraction of the thoracic wall to bring about a cure.

Fig. 166.—Bier Cup Applied to Thoracotomy Wound.

I have adopted this method in several appropriate cases, with the most satisfactory results. The operation is simple, not associated with much shock, and in the type of case for which it was designed is likely to prove adequate to cure the condition.

In those cases in which the process is of longer duration and the fibrous changes in the lung tissue are such that expansion will not take place even if the diseased visceral pleura is entirely removed, the only recourse is thoracoplasty. The operations of Estlander and Schede have been described in Vol. III., p. 553.

In my own opinion, however, the extrapleural thoracoplasty of Friedrich is to be preferred to those operations which remove not only the ribs, but the intercostal muscles and parietal pleura. Friedrich's operation (see p. 390) is certainly less hazardous, and, theoretically,

should allow as complete an obliteration of the dead pleural space as the more radical procedures.

New Growths of the Pleura.—Tuberculous Fibromata.—Rist and Ribadeau-Dumas[18] describe certain fibromata growing from the pleura which are of tuberculous origin. These growths are frequently lamellated and pedunculated. A case was reported of an enormous growth of this nature weighing over 5 kg. Courcoux has reproduced these growths experimentally by cultures of tubercle bacilli of low virulence, and applies to the condition the term "*fibrotuberculose hypertrophique.*"

Endothelioma of the Pleura.—While this disease (which was described in Chapter XLI.) gives rise to no surgical indications, for the reason that its growth is practically symptomless until it has advanced beyond the hope of operative relief, a knowledge of its general characteristics and course is of importance to surgeons, as they are not infrequently consulted regarding its diagnosis and possible treatment.

Patterson[17] has recently reviewed the literature of the subject and made an analysis of 96 cases. He reports all the cases to have ended fatally, the average duration of life after diagnosis was established, having been from six months to one year.

The general symptoms and signs in these cases were, for the most part, those described in Chapter XLI. He reports, however, a large number of metastases, the organs being, in the order of frequency, the opposite pleura, lung, liver, kidney, peritoneum, spleen, adrenals, heart, pericardium, brain, ovary, etc. Diagnosis is rarely made early, the condition in the beginning being generally mistaken for pleurisy. At a later period signs of an intrathoracic tumor are present, best appreciated after removal of the fluid.

Abscess of the Lung.—There is little to add to the description of this disease which appeared in Vol. III. Tuffier, Marion, and Loison have recently reported cases of dysenteric abscess of the lung with and without association with abscess of the liver. They advise in doubtful cases exploration by thoracotomy and careful examination of the lower lobe of the lung and upper surface of the liver. They also call attention to the difficulties in diagnosis in many cases, and state that auscultation, percussion, radiography, and puncture are often unsuccessful. They again call attention to the value of Tuffier's method of exploratory puncture with the aid of radioscopy.

Delanglade and Fiolle state that parietal adhesions exist in 90 per cent. of the cases of abscess of the lung. This percentage seems high to myself, for in a recent series of 8 or 10 cases occurring in my service at the Roosevelt Hospital there were 3 cases in which no adhesions were present.

Gangrene of the Lung.—Considerable progress has been made in the treatment of gangrenous abscess of the lung during the past three or four years.

G. Picot, in his Paris thesis of 1910, calls attention to a series of 133 cases treated expectantly, with only 10 cures, or 6.5 per cent. He advises a free opening into the chest cavity, location of the focus by pal-

pation, suture of the lung to the chest wall, opening into the cavity by thermocautery, careful inspection of the interior of the cavity by an electric head-light or reflecting mirror, the ligature of any blood-vessels, the application of a solution of zinc chlorid, and packing with balsam of Peru. He reports as complications: hemorrhage, which should be treated by packing; continued sepsis, which should be treated by releasing any retained secretions; empyema, which should be drained; bronchopneumonia, or mediastinal abscess. He reports statistics of 149 operative cases, with 105 cures and 44 deaths. A death-rate of only 26 per cent. in cases of this exceedingly fatal disorder treated surgically is most encouraging. Lenharz and Körte, in a series of 65 cases, have reported equally good results.

Cases of gangrenous abscess of the lung which have opened into a bronchus frequently do not heal on account of the inability of the cavity to close. The treatment of this condition by causing a collapse of the lung by thoracotomy and separation of adhesions, or by the production of an artificial pneumothorax, was referred to in Vol. III.

Quite recently Tuffier[22] has brought about a cure in 2 obstinate cases by an exceedingly ingenious procedure. In his first case he removed the fifth and sixth ribs, separated the parietal pleura beneath the fifth, sixth, seventh, and eighth ribs, and in the extrapleural space thus created he grafted a large lipoma removed from another patient. The wound was closed without drainage and healed kindly. Fifteen days later the cough and physical signs of the cavity had disappeared. In one month only a few râles could be heard, and an *x*-ray photograph demonstrated an obliteration of the cavity.

In his second case he also caused a limited collapse of the lung by an extrapleural rib resection, separation of the parietal pleura from the chest wall, and in this instance he filled the dead space with a mass of omentum removed from another patient five days before and preserved in an aseptic condition in an ice-box at a temperature of from 2° to 7° C. The result in this case also was excellent.

In my opinion Tuffier's method of producing a limited collapse of the lung tissue possesses decided advantages over intrapleural thoracotomy, and as it is applicable to all cases, whether adhesions are present or not, it will probably be the operation of choice, excepting in those rare cases where no adhesions exist and in which the lung can be partly collapsed by the introduction of sterile nitrogen gas.

Bronchiectasis has also been successfully treated by extrapleural thoracoplasty. Luxembourg reports a case first treated by the production of an artificial pneumothorax with nitrogen gas, and later by extrapleural resection of the first seven ribs, detaching the pleura from the cervical dome and dividing the clavicle. The result was most satisfactory. It seems to me that in a case of this kind the operation of Tuffier with a limited costal resection would be less hazardous than the operation carried out in this case.

The accumulated experience of the past few years has demonstrated that in all cases where it is desirable to effect partial or complete collapse

of the lung for the purpose of obliterating a pulmonary cavity, whether due to ordinary abscess, gangrenous abscess, bronchiectasis, or tuberculosis, extrapleural thoracoplasty is the operation of choice rather than an operation which freely opens the pleura. This, of course, applies to those cases where adhesions of the lung to the chest wall are present. In cases free from such adhesions the collapse of the lung is best produced by the simple and comparatively safe operation of introducing sterile nitrogen gas, which was described in Chapter XLI.

Actinomycosis of the Lung.—The treatment of this condition by a combination of surgery and the potassium iodid treatment, recommended in Vol. III., has shown a few cures.

Opokin and Rasumowsky collected 57 cases from Russian literature, with 8 cures. Multiple drainage operations were generally necessary, with progressively increasing doses of the iodid.

The Surgical Treatment of Tuberculosis of the Lungs.—In Vol. III., p. 544, the surgical treatment of pulmonary tuberculosis was reviewed, and the various procedures which had been employed up to that time described. The opinion there expressed was that pneumectomy for the radical removal of a tuberculous focus was not to be advised; that the opening and draining of a tuberculous cavity had little to recommend it; that drainage of a cavity which was the seat of a mixed infection was often productive of good results; but that the future of surgery in the treatment of this condition would be in the employment of measures to promote collapse and rest of the lung.

Two plans are to be recommended to produce this result: First, the creation of an artificial pneumothorax by the introduction into the pleural cavity of sterile nitrogen gas. This operation, described in Vol. III., p. 549, is indicated in those cases of unilateral early tuberculosis with or without the presence of a cavity, where it can be demonstrated that no adhesions exist to prevent collapse of the lung. Where adhesions are known to exist the second procedure should be employed, that of extrapleural thoracoplasty.

A number of plans have been suggested to accomplish this result, among which may be mentioned: A limited removal of the ribs and cartilages over a small circumscribed area of disease, to allow a moderate retraction of the chest wall and subsequent contraction of lung tissue, as recommended by Garrè, Quincke, and Kausch; the removal of 2 or 3 inches of the second, third, and fourth ribs, and the later application of a pad of gauze or spring truss, as recommended by Leonard Freeman; the establishment of an extrapleural pneumothorax by removal of one or more ribs, and stripping the parietal pleura from the chest wall over a larger area, as recommended and practised by Tuffier, or the introduction into the dead space thus produced of masses of fat or omental grafts, as successfully practised by the same surgeon.

To Friedrich,[5] of Marburg, however, is due the credit of devising the most complete extrapleural operation for producing collapse and rest of the lung. Friedrich was led to employ this method of treating pulmonary phthisis by observing a case of extensive lung tubercu-

losis complicated by a tuberculous osteomyelitis of several ribs, in which removal of the diseased ribs apparently resulted in a marked improvement in the lung lesion. Later, acting upon the advice of his colleague, Brauer, he operated upon a number of cases of unilateral tuberculosis, in which the production of an artificial pneumothorax by nitrogen gas was impossible on account of adhesions. The idea of his operation was to produce a complete collapse of the affected lung by deossification of the chest wall. To this procedure he applied the term *total pleuropneumolysis.*

The technic of the operation is as follows: He raises a large ⊔-shaped musculocutaneous flap by an incision beginning at the costosternal junction of the second rib, extending downward to the tenth, then backward and upward to a point between the scapula and the spine. This large flap, including all the outer muscles of the chest wall, is raised with the arm and scapula, exposing the ribs from their spinal attachments to the sternum. The ribs from the first to the tenth are removed by a subperiosteal resection, leaving the periosteum and intercostal muscles uninjured. In some of his later operations he mobilized the apex of the lung by separating the parietal pleura from the first rib and cervical muscles. The musculocutaneous flap is then replaced and sutured. To avoid the sudden dislocation of the heart and mediastinal strictures he dresses the arm in a horizontal or upright position, gradually lowering it to allow the heart to accustom itself to the changed conditions.

The operation results in a complete collapse of the lung, a falling together of the walls of any cavity, a diminution in the pulmonary circulation, and a slower absorption of toxic products by a retardation of the lymph-currents. The operation is indicated in unilateral tuberculosis, whether associated with cavity formation or general infiltration, and where the presence of adhesions renders nitrogen injection ineffectual.

Regarding the *results* of these operations for pulmonary tuberculosis, Forlanini[3] reports 1454 cases of artificial nitrogen pneumothorax during 1907 and 1908, with 1 death and 3 minor accidents. Brauer reports 45 cases treated with success by the same method. Muralt and Murphy have also reported many successful cases.

Freeman[4] reports 2 successful cases by his method of limited rib resection and the application of pressure over the deossified area by a pad or spring truss. Mosheims and Landerer report a number of successes after a simple limited rib resection.

Regarding total pleuropneumolysis, Friedrich in 1909 reported 8 operations in unilateral tuberculosis without complications, with 6 recoveries and 2 unimproved. In a number of other cases, with multiple tuberculosis in other organs and where the operation was incomplete, his results were not so favorable.

From a careful review of the results obtained by these various surgical procedures, I see no reason to alter the view expressed in Vol. III. and quoted at the beginning of this section.

The excellent results obtained in early tuberculosis of the lung

by hygienic measures, combined with a residence at a sufficient altitude in Colorado, New Mexico, Arizona, or a number of other favorable locations in this country or abroad, would seem to argue against surgical treatment in the majority of instances.

If, however, a given patient cannot avail himself of the advantage of a change of climate, the treatment by collapse of the lung by nitrogen injection or by one of the methods of extrapleural thoracoplasty may be tried.

Tumors of the Lung.—Calculus of the Lung.—Tuffier[21] has recently reported a case of calcareous tumor imbedded in pulmonary tissue found at operation for removal of a bullet. He described three varieties of pulmonary calculus:

1. Calculus completely imbedded in lung tissue without connection with a bronchus.
2. Calcification of an old interlobar empyema.
3. Calcification of a tracheobronchial lymph-node.

These conditions rarely give rise to symptoms, and are of interest only from a diagnostic point of view, as they all give rise to definite, well-circumscribed *x*-ray shadows.

Seydel[19] analyzed the autopsy material at the Munich Institute from 1900 to 1909 with reference to tumors of the lung and pleura. In 10,829 autopsies there were found 184 tumors of the pleura or lung.

Seydel classifies them as follows: (1) Metastatic growths, which was by far the largest group, 73.4 per cent. (2) Direct extention to lung or pleura from growth of neighboring tissues, 9.8 per cent. (3) Primary growths, 16.8 per cent.

The first class is of interest only on account of the fact that it embraces the great majority of all tumors found in these organs. Radical surgical treatment is not to be considered.

The second class represents the extensions of growths from the esophagus or chest wall, thymus, or mediastinum. These are rarely operable.

The third class of primary tumors is the one which furnishes the cases in which operation is to be considered. Seydel, however, feels that even in this class the outlook for successful surgery is discouraging.

No case of benign tumor was found in the entire series. Of the primary malignant tumors, there were 31 cases. Adding to this 92 cases he was able to collect from literature, there were 123 cases from which he made an interesting analysis.

Of 28 cases of sarcoma of the lung, 19 were clearly inoperable on account of age, extent, situation of the tumor, or metastatic deposits. Of 11 cases of pleural sarcoma only 3 were operable. Of 55 cases of lung carcinoma, 5 only could be considered operable; while in 29 cases of cancer of the pleura in only 2 could operation hold out any hope of relief. It will thus be seen that even in the class of primary growths about 73 per cent. of the sarcomata and over 90 per cent. of the carcinomata are inoperable.

Regarding the sarcomata, Seydel found that they occurred rather

more frequently in individuals over fifty, and with about the same frequency in the different lobes of the right and left lung; 42 per cent. had metastases in pleura, mediastinum, heart, liver, or spleen. The growth was generally of the round-cell or spindle-cell variety.

Cancer of the lung was found to be much more frequent after fifty years of age. On account of the greater number of cancers of the lung the proportion of cancer and sarcoma under fifty was about equal. The number of males affected was four times greater than females. Like sarcoma, the growth was found to be about equal in its distribution in the different lobes. The growth may occur as a single focus, numerous nodules, or as a massive infiltration. Its frequent association with tuberculosis was noted. Metastases were present in over 87 per cent. of the cases. These were found in the opposite lung, pleura, mediastinal nodes, liver, brain, and other organs.

Of his 29 cases of cancer of the pleura the majority occurred in individuals under forty; 14 occurred on the right side, 11 on the left, and in 4 it was present on both sides.

As it is difficult to understand how primary cancer can occur in the pleura, one is forced to the conclusion that these cases were either secondary deposits or endotheliomata.

While these statistics are discouraging regarding the outlook for a surgical cure in malignant disease of the lung, still, as there is absolutely no hope for these patients other than by early radical removal, one should be prepared to undertake operation in an early primary growth in an accessible location if the diagnosis can be made.

A few successful cases have been published, notably the one reported by Garrè, in which he removed a sarcoma of the pleura weighing 1250 gm., the patient making a good recovery, and that of Lenharz, where a cancer in the upper lobe of the lung was removed, with apparent cure, reported two years after operation.

Echinococcus Cysts of the Lung.—Considerable advance has been made during the past two or three years in the diagnosis and treatment of these cysts.

Tuffier and Martin[23] question the occurrence of primary echinococcus disease of the pleura. They believe that cases reported as such are secondary. Their experience is that the cysts occurring in the lung are generally single, the seat of election being the lower lobe of the right or left lung. The occurrence of hydatid cysts at the summit of the lung is rare.

The diagnosis, formerly difficult, has been rendered more simple owing to improved methods of observation. The evidences furnished by a careful *x*-ray examination, the presence of a marked eosinophilia, and the reaction of fixation of compliment, added to the ordinary symptoms and signs of an intrathoracic tumor, generally enable the surgeon to arrive at a positive diagnosis.

Guimbellot regards the *x*-rays as the most important diagnostic aid. The characteristics of an *x*-ray shadow of an echinococcus cyst are its round shape and well-defined borders, contrasting with cancer,

abscess, and tuberculosis, in which the shape is irregular and the borders not well defined, but shading off into the surrounding tissues. The pulsations of an aneurysm can be detected by fluoroscopy.

The treatment should be surgical, as the death-rate by medical or expectant treatment is very high.

Guimbellot advises, when possible, the employment of differential pressure. When this is impracticable, he endorses the suggestion of Delagenière, who advises opening the pleura, slowly creating a gradual pneumothorax. Then expose the lung rapidly, draw the tumor to the surface, protect the pleura by gauze pads or, better, when the tumor is near the surface and the fibrous coat not too friable, by suture to the thoracic wall. The overlying lung tissue is next incised with a scalpel to the cyst wall. This should be opened largely and the endocyst completely removed. The fibrous outer cyst should be left attached to the wall for drainage.

Guimbellot[8] collected 225 cases treated surgically, with 87 per cent. cures. If the suppurating cysts were excluded the percentage of cures was 91.8 per cent. Tuffier reports 35 operations, with 1 death; Pasquier, 108 cases, with 16 deaths. Albertin and Barjon report a case of double cyst of the right lung, one at the summit and one at the base. These were removed at two operations six months apart by the method suggested by Guimbellot. The patient recovered.

In cases where the endocyst for any reason cannot be removed, I have succeeded by simple marsupialization without removal of the endocyst. In these cases the daughter-cysts and fluid are evacuated at the time of operation, and the cavity injected daily with a solution of nitrate of silver 1: 8000, gradually increased to 1: 1000. At a later period the use of Bier cups hastens the healing of the wound.

Kaestle in 1909 reported an exceedingly interesting case of *mediastinal dermoid.* The patient had had indefinite pressure-symptoms and substernal distress for thirty years. Finally, the occurrence of spasmodic cough and the sudden expectoration of masses of sebaceous material and hair established the diagnosis. Although these tumors are rare, Morris succeeded in collecting 57 cases. As in other intrathoracic tumors, the *x*-rays furnish our most valuable diagnostic aid. Roundness, fixity, non-expansibility, and central location are the chief characteristics.

Friedrich[6] in 1910 proposed a transverse section of the sternum for exposing the superior mediastinum. His operation consisted in a transverse incision across the upper part of the sternum, extending well over the second intercostal space on either side. The bone is next divided with a saw and the intercostal muscles cut as far outward as necessary. After securing the internal mammary vessels, traction is made on the two sternal fragments until a satisfactory exposure is obtained. After the necessary operative procedures are carried out the bone-fragments are drawn together and held by bone or periosteal sutures.

THE EMPLOYMENT OF DIFFERENTIAL PRESSURE IN OPERATIONS UPON THE THORAX.

During the past five years there is perhaps no subject in connection with thoracic surgery which has received more attention than that of devising the best method of avoiding the deleterious effect of pneumothorax in operations upon the thoracic viscera. The subject was treated in Vol. III., p. 559, the methods by positive and negative pressure were considered, and the Sauerbruch cabinet, the then most satisfactory negative pressure apparatus, described and illustrated. Since that time the experimental work in this field has been tending toward the employment of methods of positive intratracheal pressure rather than those utilizing negative pressure, as in the Sauerbruch cabinet.

Willy Meyer,[15] after a large amount of experimental work, has devised one of the most perfect and complete operating chambers, by which he can use either positive or negative pressure or both combined. (For which see Vol. VI., p. 963.)

A portable positive pressure cabinet has been devised by Janeway and Green, which has been successfully employed in the Surgical Research Laboratory of the College of Physicians and Surgeons, and also in operations on the human subject (see Figs. 480 and 481). The important features of this cabinet are: first, its compactness and hence its greater portability than the larger negative or positive chambers; second, the inclusion of both the pump and motor in the space beneath the box; third, the ease and rapidity with which the patient's head can be introduced; and, fourth, the addition of the valve mechanism (A), permitting of a rhythmic rise and fall of pressure within the cabinet. This valve is so controlled by change speed-gears (B) and a cone-shaped cam (C) that not only a wide range in frequency of artificial respirations can be obtained, but also the ratio of the duration of inspiration to expiration can be varied at will. Such a cabinet, therefore, permits a true artificial respiration independent of the efforts of the patient. The apparatus also permits of the perfect control of the head of the patient by the anesthetist in case of vomiting, or the necessity of cleaning out the pharynx, or passing an instrument into the esophagus or the stomach.

Intratracheal Insufflation Anesthesia.—One of the simplest and apparently one of the safest methods of avoiding the risks of pneumothorax in thoracic operations is that of intratracheal insufflation anesthesia, first suggested by Meltzer[14] and Auer.

The essentials of the method are the introduction deep in the trachea of a flexible elastic tube, the diameter of which is much smaller than the lumen of the trachea, and the driving through the tube of a current of air which returns along the space between the tube and the trachea. By means of this plan adequate and efficient respiration can be carried on when for any reason the normal respiratory mechanism is embarrassed or fails completely. The addition of ether vapor to the air thus introduced into the trachea will result in an ideal anesthesia for the reason

that the dosage of the drug can be accurately adjusted, the embarrassments caused by spasm of the glottis, the accumulation of mucus in the pharynx, and dropping backward of the tongue are entirely avoided; and the demonstrated impossibility of any foreign substance present in the mouth or pharynx entering the trachea or bronchi.

In addition, the employment of this method completely does away with the dangers of open pneumothorax without depriving the individual of any of the factors of safety present under conditions of normal respiration.

While anesthesia by this method can be carried on with ease and safety by means of a foot-bellows, a Wolff bottle for the ether, and a

FIG. 167.—ELSBERG'S APPARATUS.
Box containing insufflation apparatus closed.

FIG. 168.—ELSBERG'S APPARATUS.
Box opened.

tracheal tube, the admirable apparatus devised by Elsberg[1] will simplify the procedure and give more satisfactory results. The following description of the apparatus is quoted from a recent communication:

The entire apparatus is contained in a wooden box which is transportable (Fig. 167). The box is placed on the floor near the head end of the operating-table and the front turned down, exposing the interior (Figs. 167, 168). By means of the switch A and the rheostat B the electric current is carried to the $\frac{1}{6}$ horse power motor C, which drives the blower D. The air passes through the tube E, the oil filter F, and the tube G into the bottle H. This bottle contains hot water, so that the air, as it bubbles through the water, is warmed, moistened, and

filtered. The current of air then passes through the tube I to the rubber tube which is connected to the intratracheal catheter. To this tube (I) is connected the ether reservoir J. The tube P leads to a foot-bellows which has been added to the apparatus as a safety device if anything should happen to the motor or blower, and is to be used where no electric current is available.

The patient is first etherized in the ordinary manner and placed on the operating-table, with the head in the Rose position. A long silk woven catheter (No. 22 or 24 of the French scale) is next introduced into the trachea under the guidance of the eye by means of a Jackson direct laryngoscope. The tip of the catheter should reach to within 5 cm. of the bifurcation. When the catheter is in place it is connected with the air-tube I and the amount of ether regulated by the hand-wheel K on the indicator. When the pleural cavity is opened the desired amount of lung expansion can be obtained by regulating the pressure by the stop-cock M.

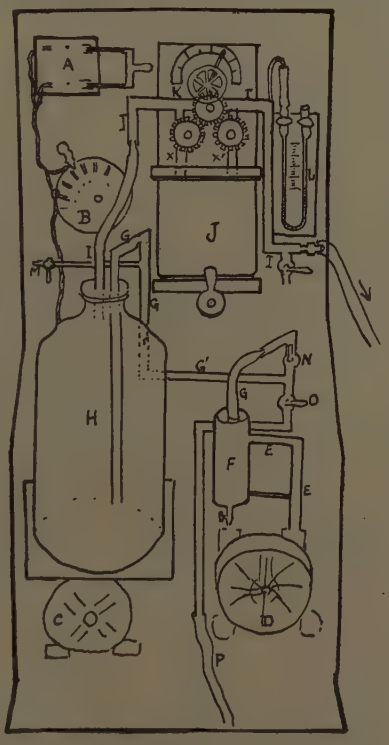

FIG. 169.—ELSBERG'S APPARATUS.
Diagram of apparatus showing essential parts.

Over 400 anesthesias by this method have been reported by Elsberg, and nearly 200 have been given at the Roosevelt Hospital without immediate or remote untoward results. The method is now in constant or frequent use not only in thoracic, but in general surgery.

Quite recently Dr. Henry H. Janeway has devised and constructed another apparatus for intratracheal anesthesia. It embodies a number of ideas resulting from the experimental work of himself and Dr. Nathan Green upon intrathoracic surgery (Figs. 170, 171). The apparatus will furnish a continuous supply of warm, filtered, and moistened air mixed with varying percentages of ether, and interrupted at regular intervals of any desired frequency. It will run upon either the direct or alternating current. It is easily portable, measuring only 18 by 8 inches, and can be carried about in a bag.

The motor (1) turns the rotary blower (2) directly, that is, without gearing or a belt. The joint between the two is a flexible or universal one. This arrangement prevents the loss of power incidental to gears or the accidents often due to the use of belts.

The current of air emerging from the blower is carried by the tube

(3) through a muffler and air filter (4) provided with a free exhaust stop-cock (5).

The main current of air then passes from the top of the muffler through the stop-cock and tube (6) to the valve (7) (Fig. 171), entering this valve behind its lower portion indicated by (8). By means of the thumb-button (9) which moves a slide valve the current of air is divided by the valve (7) into two reciprocally varying proportions, permitting thus any proportions of the whole current of air to pass through the tube (10), while the balance passes through the tube (11). The pointer (12) indicates on its dial what proportion is passing through the tubes (10) and (11). By means of the tube (10) any proportion of the current of air from 0 to 100 per cent. is passed over the surface of ether in

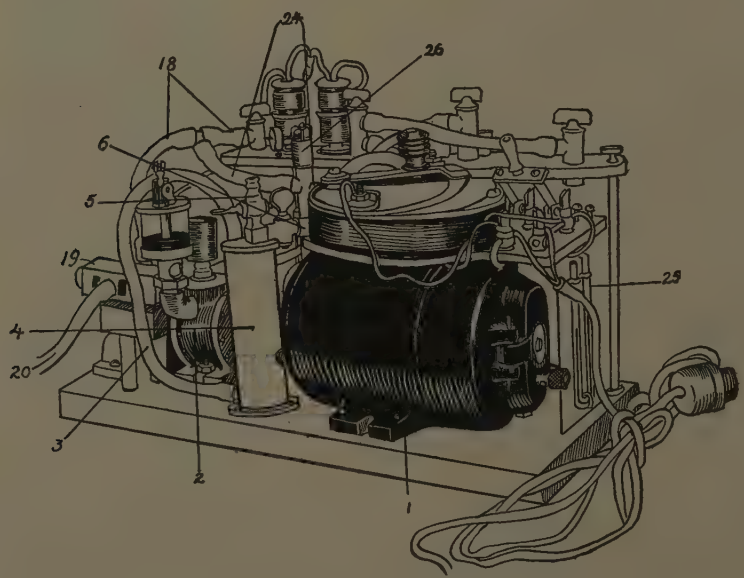

FIG. 170.—JANEWAY'S APPARATUS FOR INTRATRACHEAL INSUFFLATION ANESTHESIA.

the jar (13) and emerges mixed with ether vapor through the tube (14). By the latter it is conducted over the surface of hot water contained in jar (15). The temperature of this water is constantly kept correct by the two little electric heaters (16) which are controlled by the rheostat (17). Both the warming and moistening of inspired air has been proved by a number of recent writers to be important.

The proportion of the air current which is allowed to pass through tube (11) is conducted by it directly over the surface of the hot water, unmixed, therefore, with ether vapor. By this arrangement any desired amount of ether vapor or air unmixed with ether vapor can be passed to the patient warmed and moistened. From the jar (15) all the air is collected and passed by the tube (18) to the slide valve (19) in which it is mechanically interrupted with any desired frequency. The slide valve

(19) is so arranged that it exhausts simultaneously from both the tube of ingress (18) and the tube of egress (20). The latter passes to the catheter within the trachea of the patient. The slide valve (19) is moved by the crank (21) which is pushed by the peg or pegs inserted into the wheel (22), and which, in turn, is moved by a worm-wheel (23) upon the shaft of the blower.

In the course of the tube (18) is inserted a T-joint, by the perpendicular arm of which a connection (tube 24) is made with the manometer (25). Another T-joint in tube running to the manometer is connected with the blow-off valve (26).

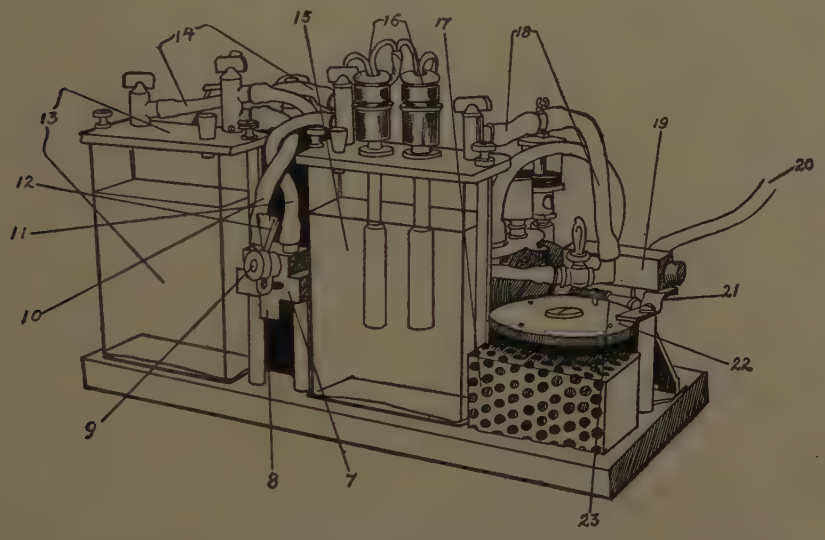

Fig. 171.—Janeway's Apparatus for Intratracheal Insufflation Anesthesia.

This safety-valve is a new and very important part of the apparatus. It is so arranged that the air-pressure cannot exceed a dangerous amount, or, in case of some accidental rise in pressure, the mercury will not blow out of the manometer, as otherwise could happen in squeezing a tube in order to make a connection with the apparatus in motion or too great an insertion of the catheter within the trachea of the patient.

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CHAPTER CXVII.

SURGERY OF THE BREAST.[1]

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In the last few years additions to our knowledge of surgery of the breast have been largely along lines of treatment. This is especially true with reference to carcinoma. Even here the advances which have been made have been largely in the nature of further elaboration of certain well-established basic principles. So far as early diagnosis is concerned, later reports have not borne out the promise of results to be

Fig. 172.—Handley's Incision.
Shaded area shows undermining of skin flaps.

obtained from the examination of the blood. The work of Kelling, Rosenbaum, Crile, Simon, and others showed apparently characteristic hemolytic reactions. More extended observations have shown that this reaction is not to be depended upon, as it can be demonstrated in a variety of other conditions.

Further study of certain predisposing causes of cancer, such as chronic mastitis associated with infection, imperfect involution from previous

[1] Supplementary to Chapter XLII., Vol. III., p. 563.

lactation, or that interesting and not even yet thoroughly understood condition commonly known as "chronic cystic mastitis," "senile parenchymatous hypertrophy," and by a variety of other names, have tended

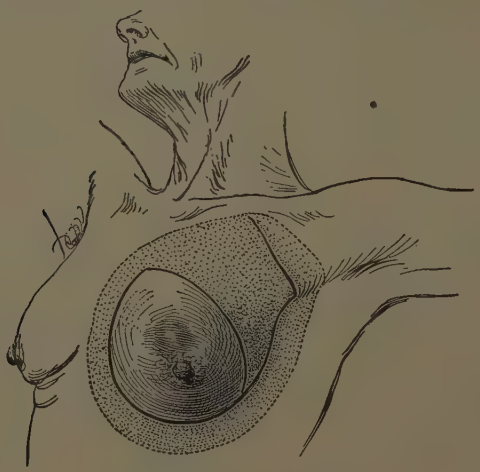


FIG. 173.—JACKSON'S INCISION.

to strengthen the position of those surgeons who have advised the complete extirpation of every breast, the seat of any one of these conditions. This practice would appear to most surgeons as too radical, their conten-

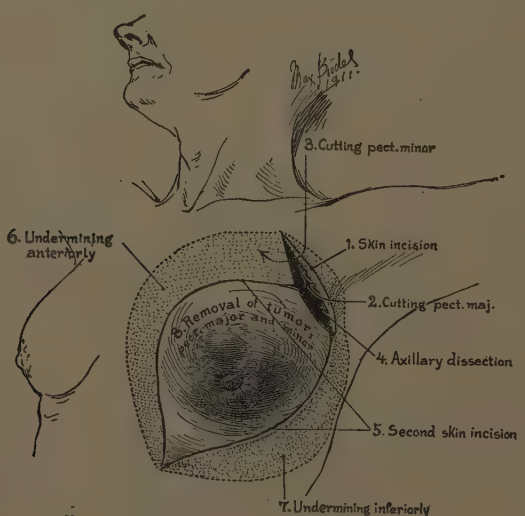
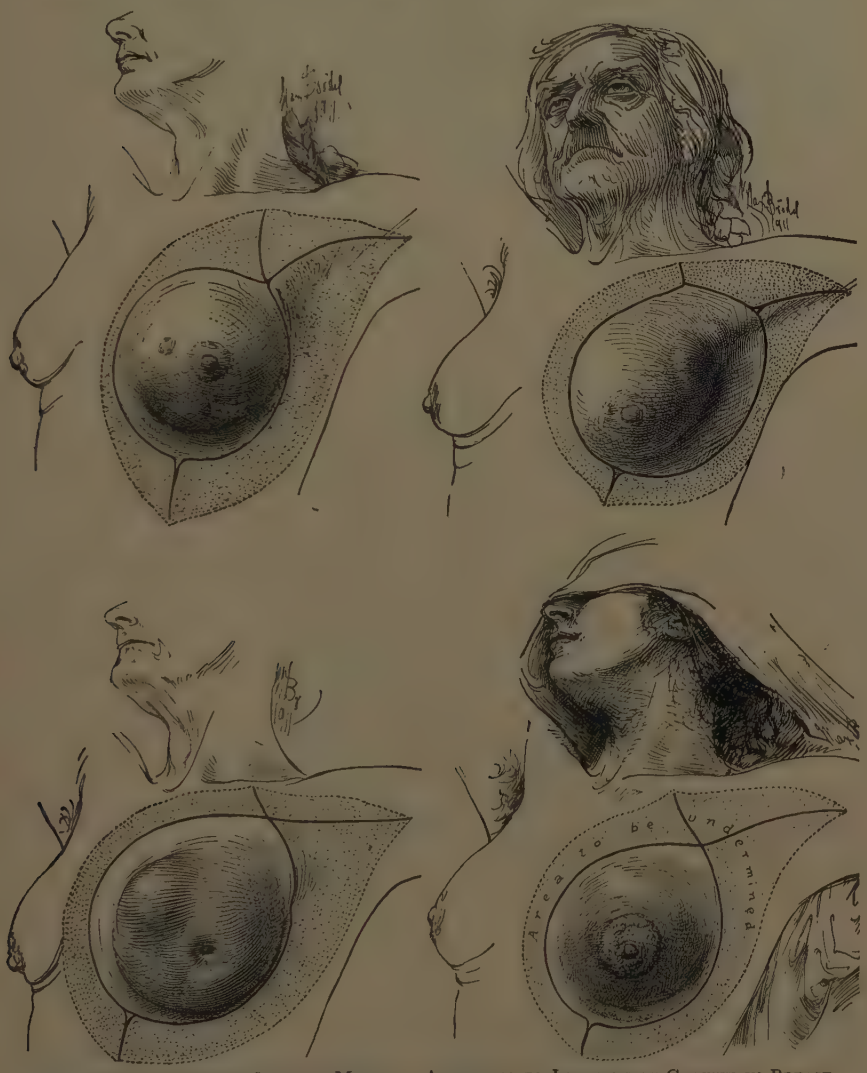

3. Cutting pect. minor
6. Undermining anteriorly
1. Skin incision
2. Cutting pect. maj.
8. Removal of tumor, pect. major and minor
4. Axillary dissection
5. Second skin incision
7. Undermining inferiorly

FIG. 174.—RODMAN'S INCISION.

tion being that the plastic operations recommended by Warren and others are sufficient.

If we are to make any real advances in the cure of cancer, new and as yet unknown methods must be devised, since those at present at our

command are clearly inadequate. If it is possible to prevent cancer by operating in the so-called precancerous stage, great results will have been accomplished by the removal of all possible sources of subsequent malignant degeneration. In the determination, therefore, of the line



FIGS. 175–178.—SHOWING INCISION MODIFIED ACCORDING TO LOCATION OF GROWTH IN BREAST.

of treatment to be followed in any given case where any one of these conditions is present, the most careful consideration should be given to the question of the advisability of the complete removal of the breast. Since we now know that no benign tumor of the breast is so simple that it may not at some time become malignant, more careful attention

should be given than has heretofore been paid to the thorough and complete removal of benign tumors, whether inflammatory or otherwise. In other words, the present-day tendency, based upon sound pathologic considerations, is setting strongly toward more radical measures in the treatment of all affections of the breast, whether benign or malignant.

On the other hand, in the matter of treatment of infections of the breast, especially those associated with lactation, the passive hyperemia treatment according to the method of Bier and Klapp seems worthy of further trial. Bernheim's careful observations show conclusively that

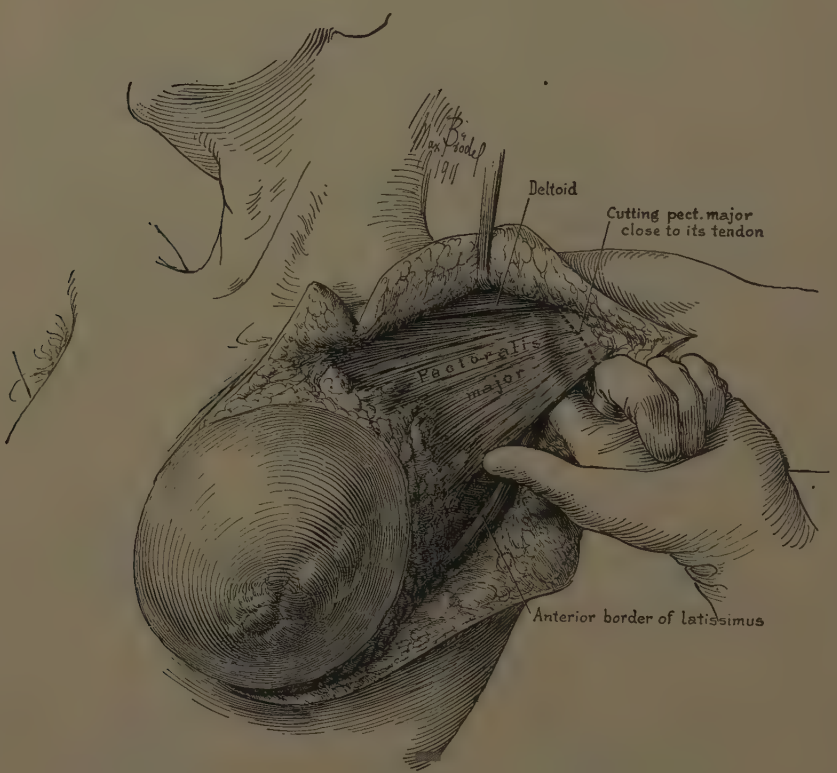


FIG. 179.

when seen early enough, that is, before the development of pus, a few treatments with the cup will frequently abort the process. Too often, however, the condition has advanced so far at the time of the first examination that only radical surgical methods are to be considered. In such instances the most conservative treatment is wide radial incisions, the breaking up with the finger of all pockets and partitions, with a through-and-through drainage at the most dependent portion. The puncture incision is to be recommended only in superficial abscesses of small extent, which variety is relatively rare. As summed up by Bernheim, the advantages of this method are—

1. Almost absolute freedom from pain during the whole course of the disease.

2. Less destruction of glandular tissue, with better preservation of function, both for present and future lactation.

3. Minimum of scar formation.

4. Shortening the course of the disease.

5. Prevention of abscess formation in cases seen early enough.

As regards the all-important question of cancer of the breast, some advance has been made perhaps by the work of Handley, in the direction of a better understanding of the phenomena observed in the prog-

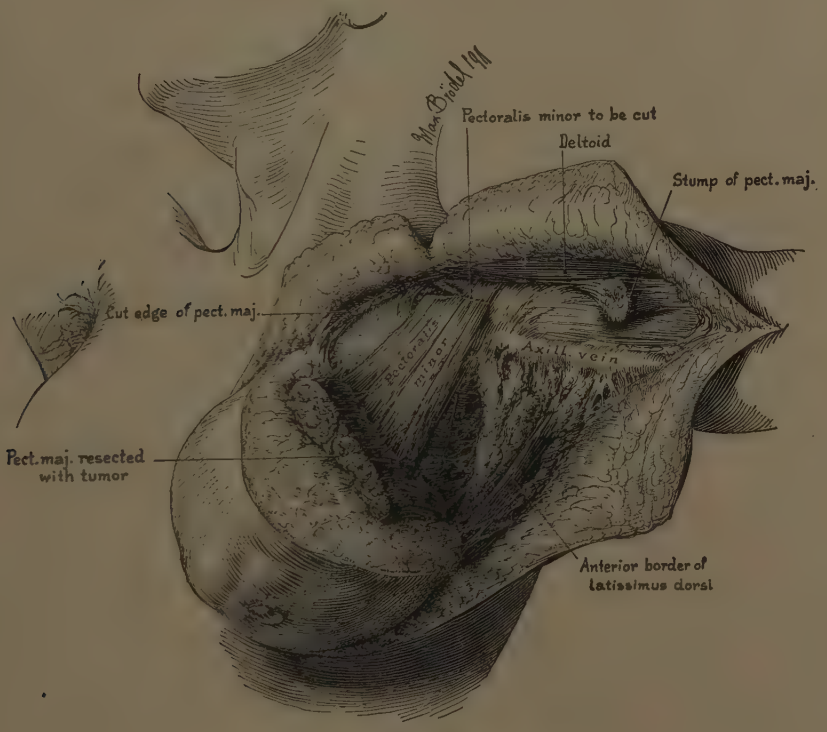


FIG. 180.

ress and extension of the disease. He claims that dissemination occurs chiefly by a process of "permeation" of the cancer-cells along the lymphatics. This process takes place primarily in the planes of the fasciæ; the infiltration of the integument and underlying muscles and neighboring viscera is a secondary process, the result of the lymphatic transmission perpendicular to these fascial planes. In this way he attempts to explain metastases occurring in the various parts of the body. His arguments are interesting and ingenious, and based upon certain facts which he has brought out as a result of a great deal of excellent work done along this line, but are not entirely convincing. As a

result of his observations, he recommends an extension of the incision downward over the upper portion of the rectus muscle, together with the removal of the fascia, claiming in this way to lessen the number of visceral recurrences.

Handley's is only one of a number of operations which have been recently devised, all really elaborations of the epoch-making work of Halsted in this direction. Other attempts in the direction of limiting the deformity and disability subsequent to his operation, as well as to

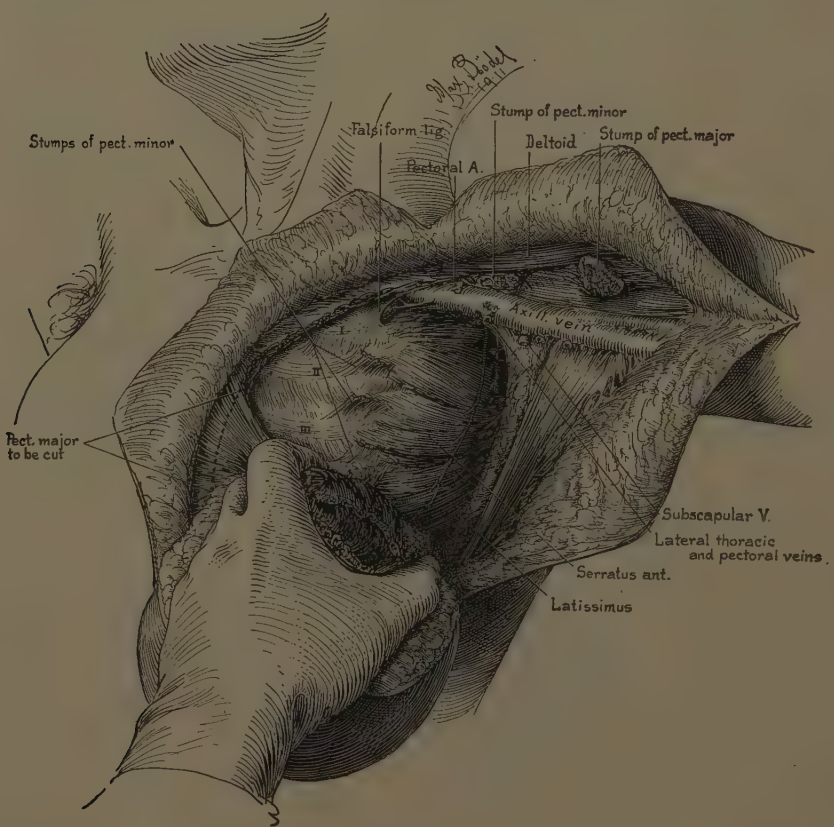


FIG. 181.

increase its extent and thoroughness, have been made by Jackson and Rodman. A distinctive feature of Rodman's operation is that through a straight incision from the clavicle to the lower border of the pectoralis major muscle he completes the axillary dissection before removing the pectoral muscles and the sheath of the rectus, as recommended by Handley. The great objection to any definite incision or any specific method of cutting the flaps is that one is always liable in the attempt to follow well-defined lines, with a view to subsequent wound closure, to encroach too closely upon dangerous ground. Follis' suggestion, that "the

man who makes the wound should never close it," is very much to the point. My own experience is that it matters little what method of operation one makes use of, so long as one gives the widest margin of skin, fascia, and muscle to the infected area, with no thought in his mind of present mutilation or future disability, which are entirely secondary considerations to the one great question, namely, the complete eradication of the malignant process. After the operation has been completed, by means of skin grafts (whole thickness or Thiersch)

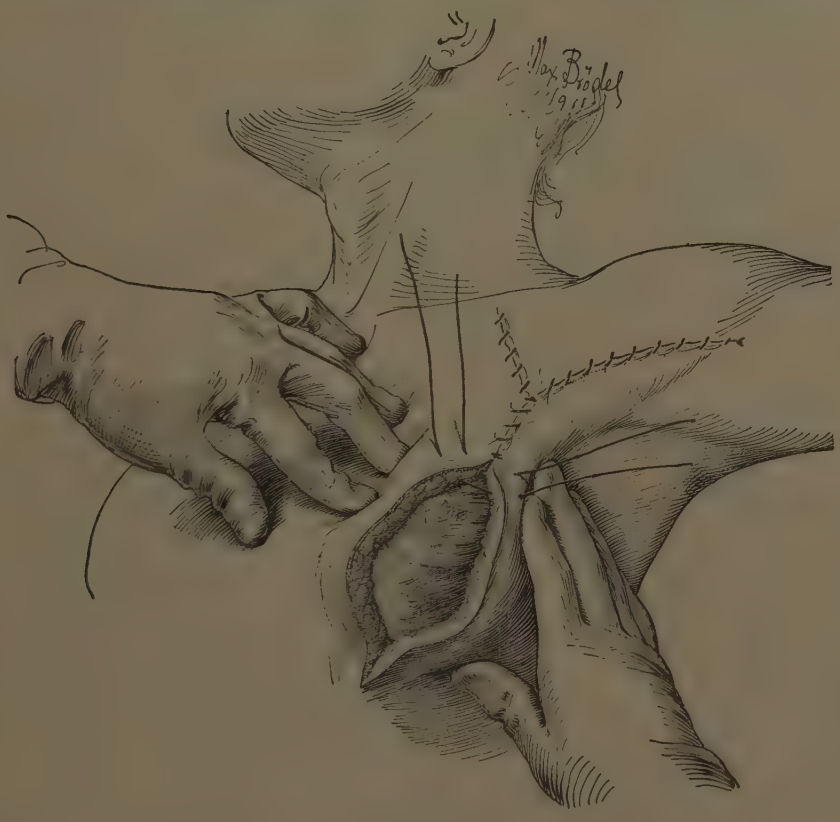


FIG. 182.

FIGS. 182–185.—SHOWING PROGRESSIVE STAGES OF OPERATION AFTER SKIN INCISION.

or by plastic flaps one endeavors, as far as possible, to repair the damage done. The complete restoration of the axilla by building it up with pledgets of soft crumpled gauze, so that the axillary skin flap is well tucked up to the apex of the axilla and held there by this means until it unites, will do more toward the retention of the function of the arm than any other means at our disposal.

In addition to the operative treatment, the use of the actual cautery in some form has been followed in certain cases by satisfactory results. Fulguration (so called) consists in an electrosurgical operation divided

into two stages: The first stage consists of the operative removal of the tumor as radically as possible. Then, in the second stage, long and powerful sparkings of great frequency and high tension are applied to the wound thus made. According to deKeating-Hart this method of treatment seems to act not so much on the neoplasm itself as on the soil upon which it grows, rendering it less fertile for the growth of the cancer. The method is too recent to pass final judgment upon the results, but Czerny thinks very favorably of it when applied in the early cases. In late cases it serves to prolong life, relieve pain, and stimulate the growth of granulations and epithelium. It will not, as at first

FIG. 183.—SHOWING TUCKING UP OF APEX OF AXILLA WITH CAREFULLY APPLIED GAUZE PAD. Of the utmost importance as regards functional result.

claimed, prevent recurrences. It seems at present that it is only one more of the many aids to the knife. Quite recently the actual cautery has come into more general use as a means of removing cancerous growths of all kinds, both in the early and late stages. The great objection to it, of course, is that it is more mutilating than the scalpel and also, as a rule, more painful. No reliable statistics have been reported as yet to determine its comparative value as a curative agent in competition with the knife. Certain it is that in local recurrences after removal of the breast it has seemed to be much more efficacious in my own experience than after removal by excision. This is true

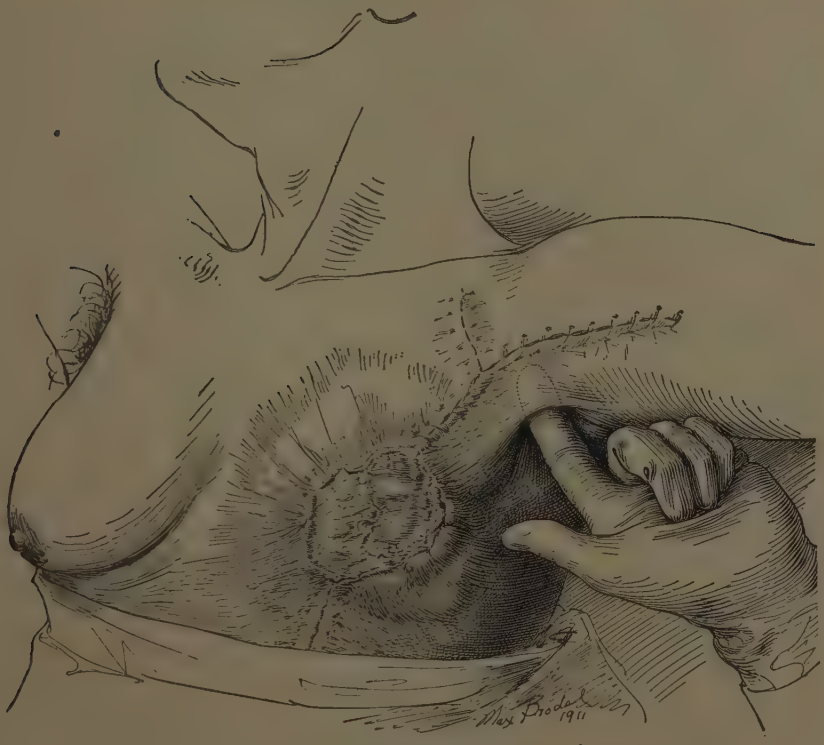


FIG. 184.—LATE RESULT SHOWING AXILLA PROPERLY RESTORED.
This case was skin grafted.

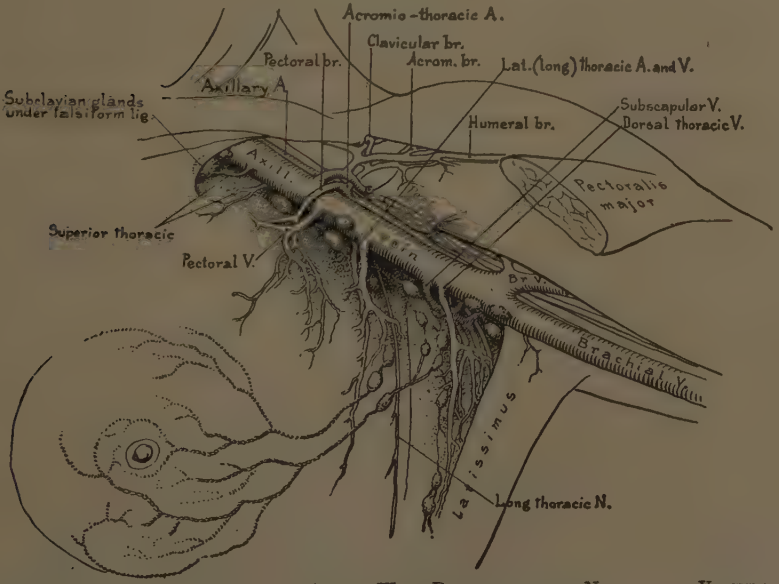


FIG. 185.—SHOWING DISSECTION OF AXILLA WITH DISTRIBUTION OF NERVES AND VESSELS.

even where the ribs and sternum have become involved. It may be necessary to use it repeatedly, but it is certainly worth while. For obvious reasons, it cannot be used at the original operation to the exclusion of the knife. Sera of various sorts have been vaunted from time to time; the latest, perhaps, are those of Hodenpyl and Doyen. Neither of them has lived up to the early extravagant claims of their exploiters, and they are not to be recommended. It is to be hoped, however, that eventually something of value may be developed along these lines.

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CHAPTER CXVIII.

SURGERY OF THE MOUTH, TEETH, AND JAWS.[1]

By Edmund Owen, D.Sc.; LL.D.; F.R.C.S.,

London.

In one of the reviews of Vol. III. of "Keen's Surgery" it was suggested that a fuller account might be given of the **radical treatment of malignant disease of the lips and tongue.** The following remarks are, therefore, written by way of supplement to the brief sketch of the operative procedures alluded to on p. 633 of that volume.

In the first place, reference must be made to the valuable work which has been done in the treatment of advanced malignant disease of the head and neck by Dr. George Crile, of Cleveland, Ohio. The substance of his teaching is to be found in the Journal of the American Medical Association for December 1, 1906. This paper by Dr. Crile and one by the late Sir Henry Butlin—to which reference will be made—give in full detail the latest and most efficient teaching in connection with the operative treatment of the disease in question. Admitting that cancer is primarily a local disease, each case is presumably curable up to a certain period by complete excision; and, if the hampering effects of tradition and convention are brushed aside, cases of malignant disease which would formerly have been considered as past all surgery may still be rescued. But to effect this an abundance of courage and doggedness is needed not only by the patient, but by the surgeon.

Extension from the primary cancerous focus is by the lymphatics, secondary cancerous deposits in distant organs being of rare occurrence. What Dr. Crile calls the "collar of lymphatics" of the neck forms a barrier through which cancer rarely penetrates.

Every part of this barrier is surgically accessible, and is more easily dealt with than is the region of lymphatic invasion in cases of cancer of the breast, the stomach, and the intestines. Mere excision of the primary focus is as unsurgical as excision of a cancerous breast with neglect of the regional lymphatic glands, while an imperfect resection of the affected "collar" causes a stimulation and a dissemination of the growth. Dr. Crile speaks of the method as a "block" dissection of the regional lymphatics as well as of the primary focus, and compares it with the Halsted operation for cancer of the breast. Further, he rightly insists that such a dissection is indicated whether the glands are or are not palpable. A special caution is given against handling the

[1] Supplementary to Chapter XLIII., Vol. III., p. 614.

carcinomatous mass lest further dissemination of the malignant cells should be set up.

Among the immediate dangers of this very thorough operation are septic infection, hemorrhage, shock, and exhaustion. In view of diminishing the risk of infection when the primary disease implicates the mouth or any other mucous area, the wound in the neck should not be made at the same time that the growth is attacked.

In order to prevent blood entering the lungs, soft tubes are passed through the nares into the pharynx for administration of the anes-

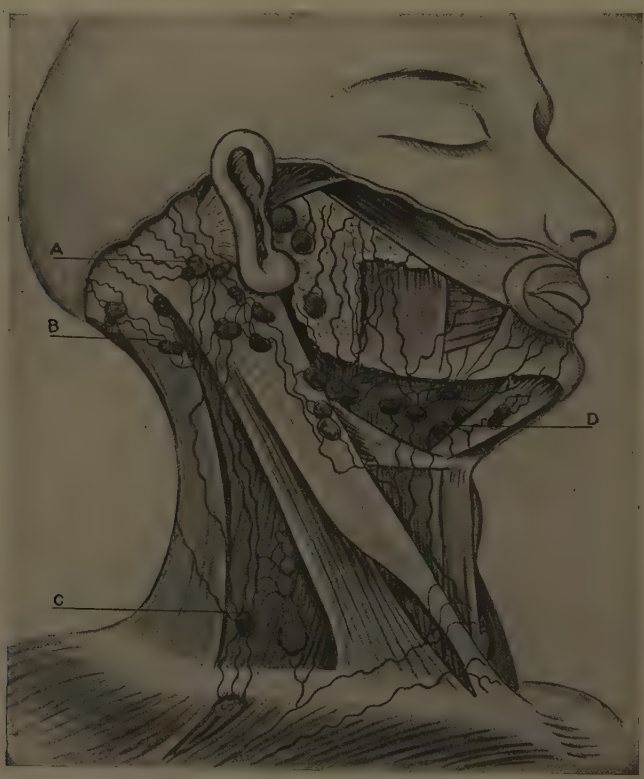

FIG. 186.—THE DISTRIBUTION OF THE SUPERFICIAL LYMPHATICS. (From Gray, Porrier, Cunéo, and Toldt.)
A, Posterior auricular glands; B, occipital glands; C, superficial cervical glands; D, submaxillary glands.

thetic, and after this the tongue is drawn forward and the pharynx is packed with gauze. This arrangement enables the surgeon and the anesthetist to carry on their work without interfering with each other.

Early in the operation the common carotid artery is sought and is subjected to temporary compression. The external and internal jugular veins are then laid bare at the root of the neck, and, having been tied in two places, are divided between the ligatures. The dissection is then begun from below upward in the deep plane of the neck, the

veins, fat, fascia, sternomastoid, and lymphatics being turned upward in a " block " and divided above. In fact, nothing but the arteries and the nerves is left.

Dr. Crile, in his valuable and important paper, urges that incomplete operations do more harm than good, and that if the operating surgeon is determined to get the best results from his work, he must give himself plenty of room for his dissection, must jealously watch against hemorrhage, and must handle the carcinomatous mass as little as may be, and, above all, he must satisfy himself that he is working through lymphatic spaces and fibrous tissues which are assuredly beyond the area of secondary invasion. Dr. Crile concludes by affirming once more that every case of cancer of the head and neck is at one time curable by complete excision; that the field of regional metastases is exceptionally accessible; that cancer cells very rarely travel beyond the " lymphatic collar " of the neck; that the growth tends to remain here localized; that by applying the same comprehensive block dissection as in the radical treatment of mammary cancer, and by freely utilizing the modern methods of surgery, the final outcome should yield better results than in almost any other portion of the body. Hemorrhage is controlled by temporary closure of the common or the external carotid artery, and this should be effected with the utmost gentleness. Crile has devised a small clamp for occluding any one of the carotids (Fig. 39, Vol. V., p. 124).

Dr. Crile's opinion that shock in deep operations upon the neck is likely to be due, in a great measure, to forcible pulling upon important structures is no doubt correct. Most surgeons have met with cases of profound collapse ensuing upon traction on the pneumogastric, the recurrent laryngeal, or some other important nerve, and many an anesthetist could quote his own experience in the same direction. The surgeon, therefore, should have plenty of room for his dissection, and he should use his scalpel rather than his finger or any other blunt instrument. The administration of a subcutaneous injection of $\frac{1}{100}$ gr. of atropin and $\frac{1}{4}$ gr. of morphin half an hour before operating is advised.

A triangular flap turned down as shown in Fig. 204, Vol. III., p. 330, gives easy access to the region in question. When the wound is large the exposed parts should be carefully protected from the air by hot saline compresses.

On the importance of clearing the lymphatic tissue from the neck in connection with the operation for cancer of the tongue, whether the lymphatic glands are palpably enlarged or not:—

The method of Sir Henry Butlin, to which it is desirable to draw special attention in this volume, is described in an Address which is published in the opening pages of the British Medical Journal for January 2, 1906. It forms an admirable pendant to Dr. Crile's paper. Sir Henry Butlin's work concerns the treatment of cancer of the tongue together with the removal of the lymphatic vessels and glands in anatomic association with that organ.

He says that in the year 1895 he first performed a planned operation

in connection with excision of the tongue for the removal of the contents of the anterior triangle of the neck, which was founded on his experience of the places in the neck in which the glands are most likely to be diseased.

He begins his operation with a preliminary laryngotomy, as this not only allows the surgeon more deliberation, but, as in Crile's method, is helpful for the anesthetist. [Possibly Meltzer's insufflation anesthesia (Vol. VI., p. 968) may be even better, as if its use is found to be practicable it would avoid the laryngotomy.] Of the cases operated on, some were easy ones and some were far advanced. "Although, naturally, most of the very bad cases have been failures, a sufficient number of them have been successes to encourage operators not to decline to operate on them. I have been astonished at the success which has attended resolute surgery in some of those in which the result seemed to be hopeless." The author was of opinion that success lay in the *early diagnosis*, and in the *routine removal of the glands* before they are obviously enlarged.

Sir Henry's paper is divided up into tables, which have evidently been prepared with great care and with equal honesty. The brief record which he gives of one case (p. 3) will attract more than a passing notice: On June 8, 1903, the right half of the tongue was removed from a gentleman of fifty-six years, the contents of the anterior triangle being dissected out at the same time. "But a mass of glands beneath the great vessels was so fixed, and the patient was so exhausted by the operation, that it was deemed inexpedient to persist in the attempt to remove them. On June 18th I summoned up my courage and again attacked the fixed glands, which were removed with considerable difficulty. The family doctor wrote me in April of this year (1908) to say that his patient is in perfect health, and has not had recurrence either in the tongue or in the glands."

This, surely, is the case of a man snatched from the jaws of death by the determined action of a bold surgeon, and the reporting of it should give great encouragement to all enterprising operators for malignant disease.

Though it may not be needful to remove the lymphatics on both sides of the neck in every case of cancer of the tongue, the necessity clearly arises when enlarged glands are found in each anterior triangle, and in those cases in which with, say, cancer on the right side of the tongue, enlarged glands are discoverable only on the left side of the neck; also when the primary growth occupies both sides of the tongue, or, being a lateral affection, it comes to the middle line of the tongue, and in those cases of rapid growth in which at or after the lingual operation columns of cancer cells are found running deeply down between the muscular fibers.

In this paper evidence is adduced of the necessity of removing the glands even in cases of quite small and recent cancer of the tongue.

In general, it is far better to do too much than too little. All glands that even by any *possibility* may be infected on both sides of the neck should be removed.

LOCAL ANESTHESIA IN OPERATIONS IN THE AREA OF DISTRIBUTION OF THE TRIGEMINAL NERVE.

Braun[1] has shown how cocain in solution may be advantageously injected into the sheath of each division of the fifth nerve in the case of intractable neuralgia. He then goes on to speak of the easy and painless way in which important operations may be performed upon the forehead, the eyelids, and the soft parts of the nose under cocain, and with photographs he very clearly illustrates his teaching. He affirms that one great advantage of this method of operating is that there is no need whatever to hurry, as in the case of operations under a general anesthetic in patients who are exhausted or who are breathing badly. He claims, moreover, that this method of operating is accompanied with an unusually small amount of bleeding. In his Fig. 14 he shows the enormous chasm remaining after the removal of the left superior maxilla with some of the right maxilla, in a case of carcinoma, the conscious man being photographed for the purpose.

On July 17, 1911, a still more desperate operation was done on a man of sixty-three years for malignant disease of the maxilla and orbit.

Realistic illustrations are also given of patients during operations for the removal of the tongue for cancer, and for the clearing out of the submaxillary and cervical regions in the case of radical operations for malignant disease.

He affirms that resection of the upper jaw under this method has lost most of its horror and danger; that preliminary tracheotomy and temporary ligation of the carotid artery are not needed, and that the plugging of the glottis around a tube is not required because the bleeding is little or nothing. He is of the opinion that the operation can be brought to a satisfactory conclusion in a more quiet, cleanly, and satisfactory manner than under a general anesthetic, and that after the operation the patient is as bright as before it, and scarcely at all collapsed. For the two years Braun has been doing these operations, he has never had occasion to resort to a general anesthetic, and he has met with no fatal result from the operation. The essay is an attractive one, but to a surgeon who, like myself, has a dread of the risks of cocain-poisoning it is not altogether convincing.

[1] Deutsch. Zeit. f. Chir., 1911, p. 321.

CHAPTER CXIX.

SURGERY OF THE TONGUE.[1]

By T. Turner Thomas, M.D.,

Philadelphia.

Local Anesthesia for Operations in the Trigeminus Region.—Braun[2] reports very satisfactory results in operations upon the parts supplied by the fifth cranial nerve from injection of the individual nerve-trunk or trunks, and direct infiltration of the part operated on. Among the operations thus performed are: Those for empyema of the frontal sinus and antrum of Highmore, the cleaning out of and other operations within the orbital cavity, operations on the bones of the nose, unilateral and bilateral resections of the upper and lower jaws, and operations on the tongue.

The anesthetization of large nerve-trunks by perineural injection of cocain solution was only possible, or at least only practicable, on parts of the body on which the Esmarch constriction bandage could be applied. The addition of adrenalin to the cocain solution has made the method applicable to other parts of the body. The substitution of novocain for cocain permits the employment without danger of a much larger quantity of the anesthetic in the neighborhood of a nerve-trunk, and to interrupt the conduction of the nerve for a much longer time. Patients upon whom large bone operations are undertaken should be given a preliminary dose of morphin or morphin-scopolamin.

For excision of the lower jaw and carcinoma operations on the tongue, the floor of the mouth, and surrounding tissues, injections localized to the region of the tongue have proved to be perfectly satisfactory. Figure 187 shows the outline on the skin surface of the part to be infiltrated for the removal of the tongue with a median division of the lower jaw. A point in the median line just above the hyoid bone marks the posterior limit of the injection area and the skin incision. The index-finger of the left hand is placed at the base of the tongue just above the epiglottis, and the injection needle is introduced at the point indicated in the illustration to the finger in the mouth at the base of the tongue. The base of the tongue is then infiltrated under the guidance of the finger, from one palatal arch to the other, in the whole thickness of the tissue, with a ½ per cent. novocain-adrenalin solution. This will avascularize and anesthetize the tongue in the posterior portion which is supplied by the glossopharyngeal nerve.

[1] Supplementary to Chapter XLIV., Vol. III., p. 655.
[2] Deutsch. Zeit. f. Chir., 1911, cxi., p. 321.

The injection of the lower lip, which is already anesthetic from the injection of the tongue, serves only in sparing a loss of blood. If the neighboring portion of the palatal arches fall within the field of operation, they are to be directly infiltrated, and if the epiglottis participates in the operation the superior laryngeal nerve can be anesthetized by infiltrating the thyrohyoid ligament with 10 c.cm. of the anesthetic fluid.

For preliminary operations for the removal of the cervical lymph-nodes the triangle *a b e* (Fig. 188) is to be infiltrated with the anesthetic, and for bilateral operations the five-angled figure *a b d c e*. In the lines *a b* and *c d* the infiltration must extend deeply to the transverse processes of the cervical vertebræ in order to anesthetize the cervical nerves, while in the remaining area the injection need be made only close under the subcutaneous fascia. If the neck operation is to extend to

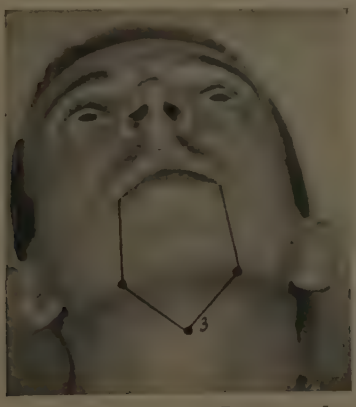

FIG. 187.—SHOWING THE POINTS OF INJECTION FOR DIVIDING THE LOWER JAW. (Braun.)

3. Typical point of puncture over the hyoid bone.

FIG. 188.—SHOWING THE POINTS OF INJECTION IN UNILATERAL (*a, b, e*) AND BILATERAL (*a, b, d, c, e*) OPERATIONS ON THE NECK. (Braun.)

the floor of the mouth (extirpation of the submaxillary salivary gland), this area is to be injected close to the border of the jaw under the guidance of the finger in the mouth. If the removal of the lymph-nodes is done simultaneously with the operation in the mouth, then the injection of the tongue area is sufficient.

For small operations on the anterior part of the tongue it will be quite sufficient to infiltrate directly the part operated on. A silk traction suture may be employed to draw the tongue forward, and, if necessary, a transverse incision may be made in the cheek. The infiltration will render the operation field completely bloodless.

Goiters of the Base of the Tongue.—Leulier[1] says that goiters of the base of the tongue have their origin in the remains of the median thyroid anlage or an ectopic portion of the thyroid body, included in

[1] Thèse de Paris, 1909; Abstracted in Presse Méd., May 18, 1910.

the base of the tongue. They present all the histologic varieties of ordinary goiters and are also more frequent in women. They give only the signs common to all benign tumors of the tongue, such as dysphonia, dysphagia, and dyspnea. They are situated behind the lingual V, are very vascular, never ulcerate, are often the seat of hemorrhages, and are never accompanied by adenopathy. The diagnosis is usually made by the laryngoscope, but confusion with thyroglossal cysts may occur. If the normal thyroid is absent and there is myxedema, there can be no doubt of the diagnosis. The complications are due to exaggerations of two symptoms, hemorrhage and disturbance of the respiration. Repeated hemorrhages may give rise to a grave anemia. From the presence of a voluminous lingual goiter a critical asphyxia may develop during sleep. All degrees of hyperthyroidism may be found. The only effective treatment is extirpation. When the thyroid body is normal the goiter should be removed entirely. To overcome the danger from the presence of a large tumor and grave hemorrhages, when the thyroid body cannot be palpated and there are any signs of myxedema, a partial extirpation should be done.

Ludwig's Angina: Sublingual Phlegmon (*Delorme*).—Ludwig's angina[1] is a rapidly spreading submaxillary cellulitis which has extended to the floor of the mouth. The sublingual phlegmon distinguishes it from a submaxillary cellulitis and is its most characteristic feature, but is not the primary condition, as was maintained by Delorme. Ludwig's angina is one of the most dangerous of all phlegmons, its recorded mortality being about 40 per cent. Its greatest danger lies in the failure of the attending physician to appreciate the importance of a sublingual phlegmon and to arrest its progress early by prompt and efficient drainage. Palpation by the finger in the floor of the mouth and in some cases inspection will easily make the diagnosis. A primary sublingual phlegmon may occur and is more dangerous than that due to extension from the submaxillary region, which was the condition described by Ludwig, and is much more frequent.

The usual course of Ludwig's angina is as follows: From a surface focus, usually within the mouth and insignificant, a severe infection passes to the submaxillary lymph-nodes, where it takes on virulent activity, leading to a rapidly spreading periadenitis. After the development of an extensive cellulitis here, or occurring simultaneously with it, the process extends to the floor of the mouth through the opening by which the submaxillary salivary gland passes in and becomes practically continuous with the sublingual gland. When the mouth is closed it is practically filled by the tongue, so that the rapidly increasing swelling, covered by the more or less rigid tongue and surrounded on all sides except posteriorly by the lower jaw, is forced to travel downward and backward to the larynx, which is only about 2½ inches from the point where the process reached the floor of the mouth. The high mortality is due to the frequency with which it extends to and occludes the larynx. The period elapsing between the beginning of the submaxil-

[1] Thomas, Annals of Surg., 1908, xlvii., pp. 161, 335.

lary cellulitis and a fatal termination is determined by the rapidity with which the edema progresses. Ludwig said that it required from ten to twelve days. In Fenwick's case the facial swelling was first observed by the patient on rising from bed in the morning and seven hours later he was dead. Edema of the larynx, regardless of its site of origin, is frequently associated with pneumonia, probably from the failure of the

FIG. 189.—TONGUE, PHARYNX, EPIGLOTTIS, ETC., FROM A CASE OF LUDWIG'S ANGINA DUE TO THE PNEUMOCOCCUS. (Coplin.)

A, Upper margin of ulcerated lingual lymph-node (lingual tonsil); B, lymph-node at base of anterior arch; this node is eroded and almost dissected out by the necrotic process; C, necrotic tonsil; the surface shows depressions resulting from necrosis of follicles; the corresponding tonsil on the opposite side has been cast off; D, ulcer in the mucosa; just below this are two prominent follicles; E, one-half of ulcerating pharyngeal tonsil, the other half can be seen on the other side; F, free margin of the swollen and necrotic epiglottis, the leader from letter F runs directly into the ulcer on one side; G, glottis and upper part of larynx containing corrugated masses of pseudomembrane; H, similar membrane on the anterior pharyngeal wall.

thickened epiglottis and laryngeal mucosa to prevent the entrance into the lung of infected mucus and other foreign substances.

The symptoms as outlined by Ludwig have never been questioned, although their cause has been much disputed. In 104 cases collected from the literature and in my own 2 I found the symptoms essentially always the same. The following is an explanation of the most important: The swelling is hard, probably because of the virulence of the

infection and, therefore, the large amount of exudate confined in this region. So long as the cellulitis is localized to the submaxillary region the patient is not in great distress, but this soon develops after the floor of the mouth is invaded. The massive, hard, submaxillary swelling prevents depression of the lower jaw and the tongue is soon crowded for room, the tip frequently protruding between the teeth, which usually separate about ½ inch. Movements of the tongue and, therefore, speaking and swallowing are hindered. The saliva dribbles from the mouth because of the dysphagia. Breathing is early interfered with by the crowding of the oral space. Soon the closing of the glottis is evident from the distressing dyspnea. Pus rarely reaches the surface of the skin because it is buried deeply under a massive, hard edema, which usually spreads to the larynx before an extensive abscess can develop.

The clinical evidence of the edema of the larynx—dyspnea—is not always manifest. Of the 104 collected cases, 25 autopsies were reported. In only 16 of these, however, was there a description of the condition of the larynx. Edema of the larynx was observed in 14, while in the remaining 2 there is some reason to question whether the condition of the larynx was determined by inspection or palpation. In these 2 the clinical and other evidence pointed strongly to the existence of a laryngeal edema. On the other hand, numerous cases have been reported in which death occurred from edema of the larynx without previous disturbance in breathing.

The treatment is obvious. Early and free incision into the focus from which the edema is spreading is urgent. As this is in the submaxillary region, the incision should be parallel to and just below the border of the jaw. The submaxillary salivary gland should be exposed if possible, and the incision extended through the mylohyoid muscle to evacuate any extension of pus to the floor of the mouth. Local anesthesia will probably be sufficient, and will be much safer than general anesthesia because of the condition of the larynx.

CHAPTER CXX.

TECHNIC OF ABDOMINAL SURGERY.[1]

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General Considerations.—The following chapters make no pretense of being exhaustive. They are supplementary to the clear, concise, judicial survey which Dr. Munro made of his subjects in Vol. III. of the main work, and are presented as an epitome of the accepted advances which have been wrought in this field since 1905–06. There is constantly increasing reason to repeat his warning that abdominal surgery should be undertaken only by those whom long training and close study have fitted for the work. "Looking-on" courses of a few weeks or months fall far short of fitting the average man to take upon his shoulders the burdens and responsibilities of the abdominal surgeon, who, at any moment in the conduct of even a case which at its inception seemed simplest, may be called upon to cope with difficulties the conscientious solution of which demand not only great technical skill, but, what is more, sound surgical judgment. Brief operative courses in the dissecting room may make one somewhat more familiar with regional anatomy, but they, too, contribute nothing to the formation of surgical sense. Apprenticeship under some competent, practising surgeon should be a qualification demanded of every man who offers to undertake the routine performance of abdominal operations.

Preliminary Treatment.—Such changes as have been adopted in this field have been in the direction of simplicity.

Preliminary Stay in Hospital.—While too long a preliminary stay is unadvisable for many reasons, yet a patient whom the operator has never seen should enter sufficiently early to allow the usual routine examinations.

Obscure cases should be thoroughly and carefully studied. It is always well to bear in mind that pneumonia, pleurisy, and pericarditis at their very outset may present absolutely no other than abdominal findings which may resemble appendicitis, peritonitis, or even the collapse of perforation. Such possibilities should act only to further the idea that consultation with the internist is something to be fostered by the surgeon. Hurry should never force a surgeon to substitute exploratory laparotomy for other means of diagnosis. Yet it is not to be forgotten that exploratory laparotomy in its place is one of our most valuable procedures; it has saved many lives, and overconservatism

[1] Supplementary to Chapter XLVI., Vol. III., p. 726.

should not keep the surgeon from undertaking it just as soon as ordinary means of diagnosis have failed to give him satisfactorily definite information. Overconservatism has claimed fully as many victims as hurry.

Weak, underfed, and underconditioned patients should be supported by food and rest, and the weak pulse of small volume should be filled and strengthened by salt solution and cardiac tonics. Worn, nervous, overworked women in particular, and those weakened by loss of blood, should not be hastened to operation, but should have an opportunity of recuperating and of having their depleted tissues filled up with fluid.

Coughs and colds are contraindications to immediate operation except in emergencies. Petechial hemorrhages in the presence of jaundice indicate that the risk of operation is very great. The use of calcium chlorid (40–60 gr. in twenty-four hours) is recommended by some in such cases. It may be given by mouth, rectally, or subcutaneously. I have never had great confidence in it, and have depended on getting large quantities of salt solution into the tissues and circulation of jaundiced patients before considering operation. Leary, following observations of Weil, recommended the use of fresh animal (rabbit) serum as a prophylactic in the treatment of hemorrhage. I have used it at the Carney Hospital in too few cases of jaundice to give a definite opinion of its value, but it is surely well worth trying: 15 c.cm. are given four days before operation and 15 more two days before operation. In severe cases the dose is repeated the morning of operation. It may be given intravenously or subcutaneously; the latter method is to be preferred, because its intravenous use is accompanied by a remote danger of hemolysis and thrombosis. The increased coagulability of the blood following its use lasts from fifteen days to several weeks. Crile advises against operation if the coagulation time of the blood is over ten minutes.

Only for exceptional reasons should cathartics be given the night before operation. A sleepless night is poor preparation for such an important event as a laparotomy. I prefer, when possible, to give castor oil the evening of the second day before operation, and to depend on a limited diet and on enemata to keep the intestines empty thereafter.

In gastric cases, particularly those with pyloric obstruction, the stomach should be washed out several times before an operation. Cases of acute intestinal obstruction should have gastric lavage just before the anesthetic is given and perhaps again before leaving the operating-room.

As a rule, a rigidly sterile diet before operation is uncalled for.

Cases of acute peritonitis should be transported to the hospital in the sitting position and kept as nearly as possible in that position during and for some time after operation.

A proper selection of cases, both as to patient and to time of operation, is very important. Hopeless cases should not be operated on unless at least temporary relief from symptoms may be fairly expected. It is the province of surgery to extend operation for the relief as well

as the cure of humanity, but when the time for either a relieving or a curative operation has passed, the surgeon should not be asked to take the burden from another's shoulders.

Both Crile and Mumford have called attention to the importance and practicability of strengthening the confidence of the patient in operation and of doing away with his dread and fear. No rules, of course, can be laid down for securing these ends. Their desirability is not to be questioned, but the ways and means must be left to the judgment of the individual surgeon.

The immediate pre-operative treatment of the operative field has been much simplified by the introduction of tincture of iodin as a means of rapidly sterilizing skin areas. Though, according to Gibson, an Austrian surgeon has resorted to its use for now fifteen years, and though Cannady made note of his own use of it in 1905, yet credit is due to Grossich, who in 1908 gave the subject its recent prominence and brought the method into its present wide use. Since Grossich's article much has been written on the subject, and the general tone has been one of praise. The method is not effective on a wet operative field. This fact cannot be emphasized too strongly. A dry skin is *a sine qua non* here; hence, in summer in temperate zones and all the year round in the tropics especial attention must be given to securing a dry field before the tincture of iodin is applied. In emergency cases even the pre-operative shave of the operative field must be a dry one if the tincture of iodin is to be used. As a matter of routine, we have been preparing the field by shaving it in the usual way the afternoon before operation. Just as the anesthetic is started a coat of tincture of iodin is applied to the abdomen and a sterile towel placed over it; when the patient is wheeled into the operating-room and before the laparotomy sheet is placed in position a second application is made. In this way the solution is given an opportunity to penetrate into the deep layers of the skin. After the sutures have been tied at the close of operation the wound area is again painted with the solution. We use a 5 per cent. alcoholic solution and have seen no eczema following it nor any marked inflammatory reaction of the skin. Some writers, it is true, blame it for postoperative eczema, for blistering, and even for gangrene of the wound edges; some, too, ascribe to its use an increase in postoperative ileus; others charge that its fumes irritate the air-passages of the operator and his helpers and cause coryza and lacrimation. I have seen none of these disagreeable results in my practice, nor have I had any infected wounds in my clean cases.

In children, however, in the aged, and in light-complexioned persons a solution not stronger than $3\frac{1}{2}$ per cent. should be used. The weaker solution should also be used on the scrotum, the vulva, and other particularly sensitive skin areas. When for any reason the skin of a patient is supposed to be hypersensitive, only a single application of the tincture should be made. In abdominal cases care should be taken to prevent iodin from the skin coming in contact with the intestines, lest adhesion formation take place later.

Kocher warns against the use of the method in the preparation of the field of operation in surgical procedures for Basedow's disease.

Certainly such practical experience as has been reported is highly favorable to its use. Relatively little experimental work with regard to it is recorded. Kinnaman has shown that it does not coagulate albumin or form inert combinations with the tissues. Some experimenters doubt its superior effectiveness as a bactericidal agent, and believe that much of what efficiency it has is due to its hardening effect on the tissues and the consequent diminution of the capability of the skin to furnish germs. Tinker concludes, on experimental grounds, that it does not fulfil the requirements for safe preparation of the skin, in that it will not destroy the spore-forming bacteria occasionally present. However, a careful reading of the report of Stretton's case (which Tinker quotes in support of his position) of tetanus following a laparotomy in which the field had been prepared by tincture of iodin does not convince one that the blame can be placed on the iodin to the exclusion of all other possible causes. Stretton himself did not believe that the iodin was responsible.

Seelig and Gould, in a most interesting recent article, state that it is a most effective germicide because it has great powers of penetration, which is really nothing more than the physical or physiologic process known as osmosis. Their experiments were carried on both *in vitro* and on the membranes of living animals.

At present it may be safely said that the weight of evidence justifies the use of iodin for the preparation of the operative field. A freshly made tincture should be used. The stains usually disappear quickly from both the skin and from fabrics; if they persist, a solution of sodium hyposulphite will remove them.

Position on the Operating-table.—It is well to give heed to Goldthwait's admonition with regard to avoiding strain on the sacro-iliac and other joints of the patient during operation. With the patient in the horizontal position, the lumbar spine should be supported by a small pillow. With the patient in the Trendelenburg position, to the lumbar support should be added a small pillow beneath the knees for the purpose of avoiding hyperextension of the thighs. Goldthwait has also had constructed an adjustable leg-rest which can be applied to any table, and which prevents strain on the sacro-iliac and lumbar joints when patients are in the lithotomy position.

It may be desirable occasionally to change from the Trendelenburg to the horizontal position during an operation, as, for instance, with the general peritoneal cavity well walled off, the finding of considerable pus in the pelvis might cause one to make such a change with the idea of avoiding possible soiling of the general cavity by oversoaking the protective pads.

The use of the Fowler position during operation for septic peritonitis is well known and needs no comment.

Bovée has called attention to the fact that in the Trendelenburg position the excretion of urine is diminished 58 per cent. in ether and

82 per cent. in chloroform anesthesia. Hence in renal inefficiency and in cardiac and arterial lesions the use of that position introduces a special element of danger.

Incisions.—Operators have not changed their ways in the past five years as far as the location of incisions is concerned. The advantages of the transverse incision are still being proclaimed by the few, but the many are still unconvinced, and the vertical incision yet retains its popularity.

Many operators, after incising the skin and subcutaneous fat, use a second knife for completing the incision, thus avoiding the possibility of carrying bacteria from the deeper layers of the skin. After the peritoneal cavity has been opened the wound surfaces may be entirely covered by sterile towels held in place by clips attaching them to the skin. Long, heavy clips (like the Morse) are to be preferred to lighter ones, because their weight keeps them out of the way.

Hoguet has called renewed attention to the importance of preserving the motor nerve-supply in making abdominal incisions. While paralyses after operative injury are relatively rare, it is only because the communication between the nerves are fairly numerous and that, after section of one nerve, its duties are assumed by another communicating with it. Certain nerves are more liable to injury in some incisions than others. In a high McBurney incision the twelfth dorsal is exposed, while the iliohypogastric may suffer in one placed low. Inguinal hernia has been a relatively frequent occurrence after the McBurney operation, especially in drained cases. This fact has been explained by trauma done to the last dorsal or to the first lumbar nerve in separating the fibers of the internal oblique and the transversalis muscles or by pressure of the drainage-tube, inflammation of the nerves following with subsequent atrophy and degeneration of the supplied muscular fibers. In the Kammerer-Battle incision the eleventh and twelfth dorsal nerves lying on the posterior sheath of the rectus are endangered, while in the making of the usual incision for operations on the kidney the twelfth dorsal and first lumbar are exposed.

Possible injury of the nerves by the rough use of retractors must not be forgotten. The hand of the trained assistant is a useful retractor that is too little employed. It is both safe and effective.

A fat abdominal wall may render access to the intra-abdominal lesions extremely difficult. In such cases Howard Kelly has practised the removal of large transverse or vertical wedges of skin and subcutaneous fat, thus getting rid of part of the thickness of the abdominal wall and making the field of operation more accessible.

The choice of incisions in operative procedures for penetrating wounds of the abdomen is sometimes perplexing. Imbert, after a lengthy study of the subject, has laid down certain rules for locating the incision in such cases. The element of uncertainty, both as to the path of the wounding instrument and as to the location and extent of the underlying lesion, is usually so great that rules are at best only provisional, and the operator must be governed entirely by the circumstances of the in-

dividual case, such as the history, the relative positions of the patient and the assailant, the character of the wounding instrument, etc. In case of absolute doubt the median incision, with possible lateral extension later, is advisable. The incision should be made large enough to insure a thorough survey of the abdominal viscera without unduly exposing them. Kehr's incision opens up a wide field and is often employed in such cases. It extends from the xiphoid cartilage to the umbilicus in the median line, then obliquely downward to the right or left of the umbilicus, and again vertically downward.

The interesting observations of Monks on intestinal localization have shown that the uppermost third of the small intestine usually occupies the upper left side of the abdomen high up underneath the ribs; the middle third occupies the middle part of the abdomen and the left iliac fossa; and the lowest third, the right iliac fossa and the pelvis. The relation of these facts to the location of incisions and to the recognition of underlying small intestine is obvious.

In certain abdominal operations which have for their object of attack disease located high in the hypochondriac regions, such as lesions of the cardiac end of the stomach, of the spleen, subphrenic or intrahepatic abscess, cysts of the convexity of the liver, etc., it may be found necessary to combine with an oblique, a T or even a straight abdominal incision, and an osteoplastic resection of one or the other costal arches. For the removal of a diseased spleen Willy Meyer carried a transverse incision outward from the lower end of a median incision to the tip of the eleventh rib. By blunt dissection along the plane between the lower surface of the belly of the left rectus in front and the peritoneum with the posterior sheath of the rectus muscles behind he easily exposed the costal cartilages and divided the seventh cartilage close to the sternum, and the seventh, eighth, ninth, and tenth near the line of their junction with the ribs. The turning back of such a flap gives easy access to localities usually almost inaccessible. Exposure of the convex portion of the hepatic lobes is facilitated by cutting the suspensory ligament of the liver and using it as a tractor. Such procedures are fortunately seldom indicated, but circumstances occasionally arise which demand their use.

Little need be added to Dr. Munro's work on the subjects of examination of the abdominal organs, sponging, walling off intestines, the control of bleeding, and rest of the wounded area. The use of moist rather than dry sponges and protective pads is or should be universal. There is danger of using too much gauze in walling off the general cavity. An unnecessary amount takes up valuable room, and is, of course, just so much more of a mechanical irritant to the peritoneum.

The intestines should be exposed to the air as little as possible, because both shock and adhesion formation are apt to follow a too prolonged exposure. Likewise, the intestines should be handled as little as is consistent with the necessary work to be done. This is particularly true with regard to the small intestine. The large intestine may be handled much more freely without injurious after-results.

The attention of operators cannot be called too strongly to the necessity of making incisions sufficiently long to permit of a thorough examination of all the intra-abdominal organs by the hand of the operator. In this connection it is well to recollect that we should always make an attempt to find adequate pathologic cause for the patient's symptoms.

Sondern, from the experimental side, and Gibson, from the clinical side, speak for the importance of the white count before operations. Their conclusions are especially applicable to appendicitis and its sequelæ. An increase in the relative number of polynuclear cells is an indication of the severity of the toxic absorption, and the degree of leukocytosis is an evidence of the body resistance toward the infection. In other words, the polynuclear percentage is an index of infection; the total leukocytosis is an index of body reaction; their proportionate relationship is an index of resistance (Wilson). The charted observations are of great value to the surgeon in cases of appendicitis between the fourth and the fourteenth day in indicating the patient's resistance or non-resistance to the infection, and the consequent necessity or non-necessity for immediate operation. The making of the differential count takes considerable time and really demands a skilled man. The examination must be made from day to day and should be charted. To moribund cases and probably to children the conclusions of Sondern will not apply. Deaver does not regard a high polymorphonuclear percentage with great alarm, provided there is a coincident high leukocyte count; in the presence of an already low count, it indicates danger. Like all laboratory experimental work its practical application must be considered in conjunction with the clinical aspect of cases.

Adhesions.—The subject of adhesions—their formation, their absorption, and, above all, their prevention—is a most interesting one to the surgeon. In fact, the prevention of infection and the prevention of postoperative adhesions are two vital principles involved in all abdominal surgery. The recent exhaustive study of Richardson has covered the subject so thoroughly and he gives so careful a résumé of our present knowledge and position in the whole matter that I shall make free use of his excellent article.

One of the most striking characteristics of the peritoneum is the rapidity with which it can form adhesions. Equally characteristic is its ability to absorb adhesions and completely to remove all traces of their previous existence. Why some adhesions persist and others disappear is not yet definitely known. The theory has been advanced that it depends on whether the causative injury has or has not led to death of the endothelium.

While the etiologic factors may be classed under two general heads—(*a*) infection and (*b*) trauma—there are numerous possibilities which are to be considered, and these, with the relative importance of each, may be summed up about as follows: (1) Blood. Though frequently associated with them, blood alone does not cause peritoneal adhesions. It forms, however, an excellent field on which infective agents may de-

velop, and it may thus secondarily cause adhesions. (2) Sutures and ligatures. These were more important in this regard in the earlier days; with the improved technic of the present day they may practically be disregarded as causes. (3) Eschar of the thermocautery. A superficial burning generally gives rise to adhesions, while a deep, thorough cauterization with the formation of a thick eschar does not produce them, the charred surface protecting the granulating surface beneath until new endothelium covers it. A practical deduction from this fact is that when the cautery is used intra-abdominally the burning should be a thorough one. (4) Air. The weight of evidence is strongly in favor of the view that air, even when free from dust and infection, exerts a harmful effect on the endothelium, and in that way plays a part in adhesion formation. (5) Infection. While it is generally admitted that adhesions can be produced by other causes than infection, it is not to be denied that the latter is a prolific cause. (6) Mechanical, chemical, and other agents. Chemicals and irritating fluids are to-day but rarely brought into contact with the peritoneum, and hence are of little importance in the present consideration. Other mechanical causes are, however, of the greatest importance. Raw, denuded areas are probably the most frequent cause of the formation of adhesions. Rough handling of the viscera, the careless use of retractors, the want of care and gentleness in the introduction of gauze pads, the use of dry gauze for pads and sponges, and unnecessary sponging, are all forms of mechanical trauma which injure the peritoneum and are conducive to the formation of adhesions. Of course, foreign bodies inadvertently left in the abdominal cavity, as well as those intentionally used as drains, etc., always form adhesions.

It follows from a consideration of the causes that certain prophylactic measures must play an important part in avoiding the formation of adhesions. Strict asepsis, avoidance of all mechanical trauma, the careful covering of all denuded areas, the use of moist gauze for pads and sponges, abstaining from rough handling of the intestines and protection of the latter from the air are efficacious preventive measures. But even the most careful observance of all these will not do away entirely with adhesion formation. As a consequence, artificial means and procedures have been offered and tried with the same object in view. Richardson believes that all of them have now been on trial sufficiently long for an estimate of their value to be formed. He has classified them under the following heads: (1) Non-absorbable protective membranes (collodion film, silver foil, solution of gutta-percha in chloroform, thin sheets of rubber or of silk fabric, etc.). These are not recommended for general use; they are seldom successful in protecting the raw surfaces. (2) Manual and postural arrangement of the viscera. These are of evident value. The careful reposition of the omentum and of the sigmoid is well known and widely practised. The postoperative posture in bed will be useful in causing the abdominal contents to fall away by gravity from raw areas. (3) The postoperative use of physostigmin for the sole purpose of preventing adhesions is of doubtful value. Even

if, as many claim, it increases peristalsis, that fact in my judgment has but little value in the real prevention of adhesions. (4) Specific drugs. The iodids are mentioned, but I know of no surgeon who believes in their use for this purpose. Thiosinamin and fibrolysin may be theoretically of value, but their practical value has not yet been demonstrated conclusively. Richardson looks forward to a wide future field for the antifibrin ferments, since they prevent the coagulation of exuded serum, which is the first stage of adhesions. (5) Normal salt solution left in the abdomen at the close of operation has not proved of much value in this connection, because its absorption is too rapid and the fluid gravitates to the dependent portions of the cavity. (6) Distention of the abdomen with oxygen gas just before closing the peritoneum and the postoperative application of hot air are recent suggestions. Gelinsky is a strong advocate of the hot-air treatment, and, though its action is more directed toward the treatment of meteorism, he believes it excites the activity of the intestines, aids absorption, and prevents adhesions. The value of both these suggestions is at least problematic. (7) Cauterization with the actual cautery may be useful under some circumstances. It should not be used when other methods are available, but, if used, the application should be thorough. (8) Lubricants. Various oils have been used with the hope of preventing adhesions, but their success has not been such as to bring them into wide use. Crump has prepared a special neutral animal oil from the appendices epiploicæ of cattle. It is said to be bactericidal. (9) Non-viable animal membranes. This class is best typified by Cargyle membrane. Their successful use has been only sporadic; it is certainly not constant and they are not to be recommended. (10) Viable grafts. It is not to be doubted that omental grafts take quickly, but they do not prevent adhesions except when applied to the abdominal parietes or to organs possessing strong peristalsis, such as the stomach and bladder. One of their important uses is the strengthening of weak places in the intestines and the reinforcing of suture lines. Richardson believes that grafts of fresh omentum and peritoneum have a wide field of application.

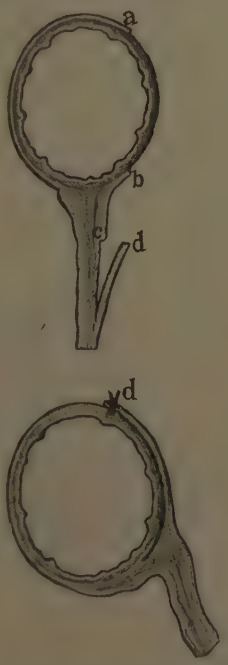

FIG. 190.—THE BOWEL AND ITS MESENTERY ARE REPRESENTED IN CROSS-SECTION. (Richardson, Bulletin of Johns Hopkins Hospital.)

In the upper drawing the area between *a* and *b* is the raw surface; *c* marks the point of incision through one peritoneal leaf of the mesentery, and *d*, the flap to be freed and drawn up. The lower drawing shows the flap *d* closely applied over the denuded area and fixed by sutures.

He offers a new and valuable method of covering denuded areas on the small intestine. When there is a considerable layer of fat between

the leaflets of the mesentery, an incision is made through the peritoneum of the mesentery close to its reflection from the bowel, and one leaflet, with its attached fat, is separated from the underlying vessels and the opposite intact leaflet. The movable flap of peritoneum thus formed is drawn up, spread out over the denuded area on the intestine and fixed in place by a few sutures, which should penetrate the submucosa (Fig. 190). In cases where the mesentery has but little fat, and when, as a consequence, separation of the leaflets would be difficult, a fold of both leaves of the mesentery (plication) without incising either will be found effectual for covering the denuded area (Fig. 191). Richardson determined by experiment that the resulting axial rotation of the bowel had no serious obstructive effect on the lumen. It can be safely extended to include nearly one-half the circumference of the bowel and from 3 to 4 inches in continuity. The effect on the circulation is neg-

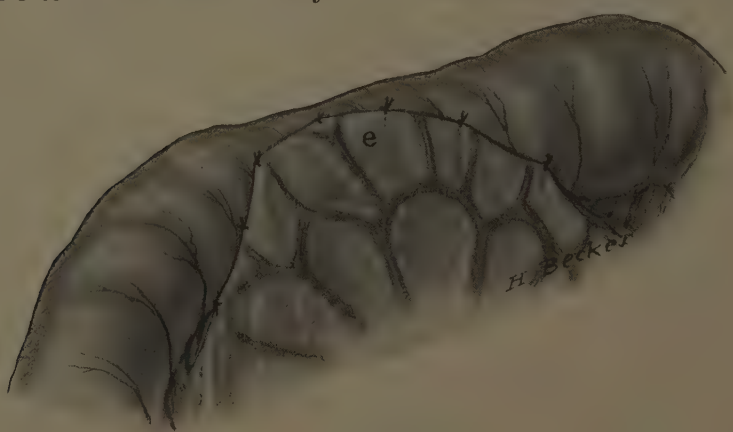

Fig. 191.—The Plication Method is Here Shown. (Richardson, Bulletin of Johns Hopkins Hospital.)
Both leaves of the mesentery are grasped together at the proper distance from the bowel border, lifted up over the raw surface, and fixed by sutures.

ligible. Care must be exercised at the duodenum, upper jejunum, and lower ilium not to produce kinks. The holding sutures must be carefully and intelligently applied. It is, of course, evident that a proper selection of cases must be made for the use of this procedure.

Summers calls attention to a valuable method for covering the extensive denuded areas which, of necessity, often follow pelvic surgery. These procedures have been used and reported by foreign surgeons, but have not gained in America the wide use they deserve. In such cases, by first mobilizing and transplanting the neighboring peritoneum or by transporting neighboring organs covered with peritoneum, the bare areas may be protected. Amann has separated the peritoneum from the abdominal wall, commencing at the lower angle of the incision near the space of Retzius and at the sides freeing some from the bladder also, and has utilized these flaps in covering over the posterior wall of the pelvis. The sigmoid has been transported by Summers across the pelvis

and sutured in such a way that all raw surfaces are covered. When the uterus is preserved the sigmoid is sutured to the side of the pelvis and to the fundus of the uterus. When the uterus has been removed, the sigmoid is sutured to the sides of the excavation and to the bladder.

Drainage and Position.—Position with its resultant gravity effects has become so important a factor in peritoneal drainage that the subjects must be considered together. It is generally understood that all parts of the peritoneum are capable of both exudation and absorption, and that the lower or pelvic zone is most exudative and absorbs but slowly, while the characteristic of the upper or diaphragmatic zone is rapidity of absorption. With these fundamental facts in mind Clark advocated the pelvis-high position as a substitute for drainage in certain cases, and Fowler the directly opposite, or the pelvis-low position, as an aid to drainage in practically all cases. The question between the two positions need not be confusing if it is borne in mind that Clark distinctly says that his position is not to be used in cases of purulent peritonitis, and, as must naturally follow from that statement, not in cases where that sequela is much to be expected. In aseptic cases we can favor the absorption of the serous exudate by the Clark position. The fluid gravitates to the region of the diaphragm and is quickly absorbed.

In cases of infection the Fowler position is the rational one. Not only does it cause the fluid to gravitate into the pelvis and give opportunity for its partial removal by drainage, but, what is more important, these toxic fluids are more slowly absorbed in that position and the system is given a much better opportunity of combating the gradually absorbed poisonous dose. The flank of the affected side should be depressed so that the spread of the infection to the opposite side may be retarded (Yates).

The longitudinal (spinal column) and the transverse (brim of pelvis with the psoas muscles lying on it) watersheds of the peritoneum play an important part in directing the course of infections within the peritoneal cavity. Coffey has shown experimentally that with the patient in the supine position the flanks are more than 1 inch deeper than the pelvic cavity and that they hold more fluid than the pelvis; hence, to effectually drain all parts of the peritoneal cavity into the pelvis a sitting position at an angle of 60 to 70 degrees must be assumed by the patient. Various expedients, all more or less uncomfortable and unsatisfactory, were used for supporting patients steadily and comfortably in this position until Gatch devised his bed (Figs. 192, 193) for this purpose. It is simple, adjustable, strong, and comfortable for both the patients and the attendants. It is satisfactory in every way and should be widely used.

Coffey has made another valuable observation, viz., that by placing a patient in a lateral position almost all the peritoneal cavities may be drained. The importance of this fact in the drainage of appendicitis is manifest.

Touching drainage solely and in particular, two most interesting

fundamental studies have recently been made in this country by Yates and by Coffey. These, together with the earlier work of Clark, cover the whole subject pretty thoroughly. Certain facts appear to be established on a firm basis and these will be briefly recapitulated. The two mechanical principles involved in peritoneal drainage are gravity (which acts so as to bring the exudate in contact with the drain) and capillarity (which acts so as to deliver the fluid to the surface). Any

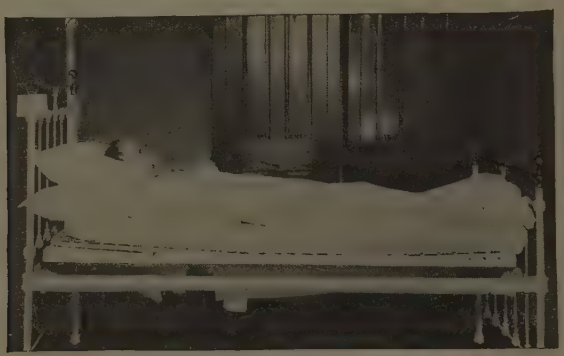

FIG. 192.—THE GATCH BED. (Kelly.)

form of drain is isolated from the free peritoneal cavity in a few hours, and then, of course, ceases to be effective. Gauze (free from fat) or capillary drainage is the most widely applicable of all drains if used in sufficient quantity to preclude its being choked by débris, and provided that the drain is as large as or larger in circumference at its exit than it is at any point of its course, and provided, too, that it is in

FIG. 193.—THE GATCH BED. (Kelly.)

contact with abundance of dressings on the outside. Moistened and wrung out gauze will drain more quickly and more profusely than dry gauze. The gauze should be wider at its outer, free end. Voluminous moist dressings over the free, outer end increase the amount of drainage. A dry dressing may be put outside the moist. The exit for the drainage should be reasonably ample; the edges of the wound should not constrict the drain anywhere in its course. Gauze

drains should always be covered with protective or enclosed in split-rubber tubing. By mechanical irritation a drain causes a flow of serum out of all proportion to the fluid in the cavity to be drained, but in direct proportion to the amount of drainage material inserted. This serous fluid is a solvent of thick pus and blood and is thus useful in preparing them for delivery to the surface—something which gauze drainage cannot accomplish with thick pus and blood as such. A simple tubular drain will drain a walled-off cavity perfectly, but is not so surely effective in draining the general peritoneal cavity. One of the most effective drains is furnished by a number of split tubes carrying gauze cigarette drains (Vol. III., p. 715) side by side. A double capillary action is thus obtained.

A line drawn from the center of the surface of the perineum to the tip of either shoulder will pass through the deepest part of the pelvis and of either flank. These lines form the right and left drainage lines of Coffey. Drainage should never be placed between these lines except just above the pubic bones. The deepest points of the flanks are best and most safely drained external to these lines; clinical experience has shown that a drain should always be in contact with the parietal peritoneum on at least one side.

On these principles must our judgments be formed of the kind of drain to be used and of the position in which it is to be placed. It is useless to try to write out definite rules. Experience and common sense are necessary to the best use of drainage. In general, those types of cases in which there is a free purulent exudate in the peritoneal cavity (excepting, of course, the inflammatory type of serous exudation in which the tissues are simply pouring out an "irritation" exudate) should be drained. I believe one is safer in following the general principle to drain when in doubt, as to whether or not drainage should be used. As a rule, the deep drains should be out in from thirty-six to forty-eight hours. Of late I have given up drainage through separate stab-wounds except in certain occasional cases. In surgical procedures confined to the female pelvis experience has led me to adopt vaginal drainage much more frequently than formerly in cases that demand drainage. A T-tube may be used for such drainage and the vaginal dressing should be changed frequently.

Closure of Wounds.—The theoretic requirement of careful approximation of layers, as well as the practical requirement of strength and as complete an obliteration as possible of all dead space, is well met by the commonly used method of closing the abdominal incision with sutures of the fascia in layers and of placing additional deep supporting ("stay") sutures. Every operative wound means necessary destruction of tissue and the formation of a traumatic exudate at and for some distance about the point of injury. In aseptic wounds the amount of exudate is in proportion to the amount of injury. The greater the exudate, the larger will be the amount of granulation tissue in and about the wound; consequently, all unnecessary trauma to the wound, both in the making and after it, should be carefully avoided.

F. T. Murphy has shown by experiment that the weight-bearing part of the scar in wounds of the abdominal wall arises practically entirely from the connective tissue, and that this latter has its origin by proliferation from two main sources, the fascia and the intermuscular connective-tissue fibers. The importance of carefully approximating these layers is thus manifest. It has been demonstrated microscopically that overlapped layers of fascia persist and preserve their identity at the end of four weeks. Overlapping of fascia is, then, a good feature, of practical use in itself and also by bringing the muscles closer together.

Clinical results are the final test by which a surgical procedure must be judged. For that reason a surgeon who is certain that he is getting no more postoperative herniæ than the character of his cases justifies has no ground for changing his method of closing abdominal wounds. A surgeon should adopt and become familiar with one method, and should depart from it only for very good reason. The many excellent methods of closure made public in our journals indicate that all men are not satisfied with the same method. Any closure that covers the requirements laid down in the first paragraph is a correct one and will prove satisfactory.

As a rule the continuous suture is the suture of choice in aseptic abdominal wounds. However, in wounds that are unusually open to infection (as those, for instance, through which drainage of septic exudates, etc., is made) the suture should be interrupted. I believe this is true, too, in wounds to the edges of which much trauma has been done, as by strong retracting, etc. In both instances just enough sutures are better than too many. The spaces between the interrupted sutures give an opportunity for the exudate to escape and certainly lessen the chances of a totally infected wound.

In fat abdominal walls operative wounds in the region of the gall-bladder, and, to a less extent, perhaps those made for the purpose of operating on the duodenum or stomach, are notoriously difficult of satisfactory closure. Here it is often necessary to include a portion or the whole of the muscular layer in the peritoneal suture. However, a continuous mattress suture through the peritoneum may suffice for the closure of that layer. It is well to remember that sutures through muscular tissue should never be pulled tight. *Approximation*, not *constriction*, is the object of the suture. In median wounds in the epigastric region a continuous suture with alternate bites, first through the anterior sheath and then through the sheath and all underlying layers, is satisfactory. Only the bite through the sheath alone should be tightened to any great extent. In all these wounds where the tension is great, chromic catgut should be used. In cases of extreme tension, and in patients who are for any reason to be got out of bed very early, mattress sutures of linen thread should be placed through the anterior sheath.

In the closure of the skin itself various forms of suture or metal clips may be used. Wyllys Andrews, of Chicago, has devised an excellent modification of the Michel skin clips, and also a most ingenious

hand-sewing machine for shortening the time required to close abdominal wounds, which is often undesirably and disproportionately long. Of late I have relied upon interrupted sutures of silkworm-gut for closing the cutaneous wound.

In infected wounds of the abdominal wall Bartlett has used with great success a silver wire (No. 30) filigree as a prophylactic against future hernia (Fig. 194). In the Mikulicz clinic in Breslau two-thirds of infected abdominal wounds were later the seat of hernia. This fact alone shows the need of a successful preventive. Bartlett has used the filigree in 6 infected wounds. The results have been entirely satisfactory. If used at all, the filigree must be implanted beneath the turned-back edges of the anterior sheath of the muscle or, better, beneath the muscle itself, and should be anchored at its lower end by a stitch or stitches. The method is certainly deserving of wide trial.

Fig. 194.—The Bartlett Filigree. (Journal of American Medical Association.)

After-treatment.—It is true that "masterly inactivity," as Deaver puts it, should be the key-note of our after-treatment. A small dose of morphin the day of the operation and perhaps the night following, with a low enema on the next morning, will keep the patient comfortable in the large majority of cases. There is no routine treatment.

What is done must be adapted to the individual case. Simplicity should be our object. Do as little as possible. A well-trained, observant nurse will do away with much of the discomfort that the first twenty-four hours after operation often bring to a patient. A special nurse for that length of time at least is an excellent investment.

Sensible, general preparation of the patient before operation, skill and care in the conduct of the anesthetization, and the avoidance of unnecessary trauma of any kind during the operation itself will, as a rule, prevent the appearance of marked postoperative discomfort.

It is certain that the use of permanent trained anesthetists in our clinics has done much to lessen the number and severity of certain postoperative complications, such as shock, nausea, vomiting, and the pulmonary complications. The recently introduced methods of anesthetization (the nitrous-oxid-oxygen-ether method, the Gatch method, and the insufflation method) have contributed their full share to the result.

We place many of our abdominal cases on the Gatch bed after operation and we find nausea and vomiting are less in the position thus assumed. It is not suitable for all cases. Judgment must be exercised. A badly acting heart is a contra-indication to its use. When nausea and vomiting occur, whether due to the anesthetic or independent of it,

gastric lavage is the only treatment worthy of mention. Withhold drugs and food by mouth. Gibbon calls attention to the fact that drainage-tubes in the peritoneal cavity may produce reflex vomiting, which will cease with their removal.

Gas-pains and the usual accompanying meteorism are most distressing postoperative features. The avoidance of handling the intestines and of exposing them unduly during operation should be carefully observed as a preventive measure. Yet, despite all care, these sequelæ will sometimes occur. Relief is obtained only by the passage of flatus. How shall we bring this about? Here, too, the Fowler position is useful. The abdominal muscles are better able to contract and to expel the gas; there is less pressure on the heart and diaphragm by the distended coils. One of the most useful agents is heat. When the necessary hot-air cabinet is to be had, the patient's abdomen can be subjected to a dry heat of from 130° to 150° C. for twenty minutes once or twice daily. Gelinsky has found this treatment most satisfactory. Pearse, of Kansas City, has used a 500-candlepower "leucodescent" light in several cases with good results. Such apparatus, however, is often not at hand. With the wound protected, hot turpentine stupes may be applied to the abdomen, and these often give great relief. Massage of the abdomen should be employed. The use of rectal enemata and of the rectal tube is well known. Eserin salicylate ($\frac{1}{60}$–$\frac{1}{40}$ gr.) is of undoubted value in some cases. It should be given after the operation and its effect is simply temporary. It acts only on the small intestine, and rectal enemata should be given one to four hours later to remove the flatus from the large bowel. It is well to remember that it is not to be used in cases with any marked degree of peritonitis, and that mechanical obstruction is a positive contra-indication to its use. This fact calls attention to the importance of distinguishing between ileus and pseudo-ileus. As in all other fields in medicine, here, too, intelligent treatment presupposes accurate diagnosis.

Hormonal (15 to 20 c.cm. subcutaneously) is regarded by Henle as superior to eserin, in that the former acts upon the whole intestinal tract. It may be used intravenously or subcutaneously; the latter method of use is now more common. Disagreeable symptoms (chill, fever, malaise, etc.) may follow the injection of the drug, but their degree is usually mild and their duration brief.

In the acute distention of septic peritonitis none of these methods is of avail.

Acute gastric dilatation will often simulate acute intestinal distention. The stomach-tube offers means of both diagnosis and treatment. The symptoms are vomiting, pain, abdominal distention and tenderness, constipation, scanty urine, and often collapse. These patients are apt to complain of a pain and of distress beneath the left costal border. This pain is fairly constant and is not influenced by the respiratory movements. The hypothesis of duodenal obstruction is now accepted as accounting for a part at least of the symptoms. Two forms of obstruction have been suggested as possible: one, caused by flexion of the

duodenum due to prolapse of the heavy distended stomach or by pressure of the superincumbent stomach on those parts of the duodenum which lie in contact with the front and left side of the vertebral column; the other, due to mesenteric traction, the mesenteric vessels being dragged taut across the transverse portion of the duodenum by the weight of the collapsed small intestine, which is usually found prolapsed into the true pelvis. The treatment is lavage and the prone position.

Retention of urine should not be treated by catheterization until all other means of relief have failed. With a firm abdominal bandage there is no reason why a patient should not be allowed to get out of bed and attempt urination. Some patients find it impossible to pass urine while lying down. The injection into the urethra of a weak solution of formalin or boric acid in glycerin will sometimes have the desired effect.

In partial or complete suppression of urine, besides the usual well-known treatment directed to the general condition, spartein sulphate may be of much use. It must be given in large doses to be of avail: 1 to 2 grains hypodermically every four to six hours should be used. I believe, however, that the best treatment is preventive. See to it that patients have plenty of water by mouth or otherwise for twenty-four to forty-eight hours before operation and postoperative suppression of urine will be a rare occurrence.

I make it a rule to give a pint of salt solution by rectum practically after all laparotomies, and, in fact, to all patients who have had operations of any magnitude, immediately upon their return to the ward.

Patients are allowed to change their position in bed frequently. Mummery well says that the position of greatest comfort is the position of greatest rest and therefore the best.

The question of early getting out of bed after operation is one that has caused wide discussion. It should be very evident that no routine rules can be laid down. Common sense should be our guide. The condition of the individual is the one thing to be regarded. No patient should be allowed to get out of bed early without firm support of his wound either by bandage or by strapping. The dressing should carry the whole stress of the intra-abdominal strain and pressure. Even in cachectic patients on whom a simple, rapid, exploratory laparotomy has been done, and to whom staying in bed would be an added source of danger, careful fortifying of the fascial layers with unabsorbable sutures should be provided in the closure of the abdominal wound. Weak, nervously worn women should not be hurried out of bed even after slight abdominal operations. To many of these women the rest in bed and the relief from care are often of far more importance as a measure of relief than the surgical procedure itself. No printed rules can make up for a lack of good judgment. It must not be forgotten that between letting patients sit out of bed comfortably and quietly and letting them do just as they please there is a wide difference. Moderation of activity should be observed in all cases.

Postoperative Neurasthenia.—The best treatment is preventive. When the question of operation on a neurasthenic arises, all means of relief other than surgical should be tried first. Avoid operation if possible. Operate only for reasons that would absolutely demand operation were the patient in good health. Too many neurasthenics have been operated on with the hope that the operation itself will give the desired cure. Such patients are usually worse off than ever in a few months.

Gastric and Intestinal Postoperative Hemorrhages.—Postoperative hemorrhage into the stomach or duodenum due to small ulcers or erosions may develop after an abdominal operation. Such hemorrhage is seldom seen in other than septic cases and the point of origin is only rarely below the duodenum. The lesions are usually caused either (1) by plugging of the veins through retrograde emboli from thrombosed masses in ligated omentum or mesentery, or in thrombi originating there, or (2) from injury of the vessels by toxins coursing in the blood. These hemorrhages usually come in the first three days after operation, and in the majority of cases are of grave import. According to Hutchinson a severe septic infection with secondary anemia is present in 80 per cent. of these cases before operation, and the latter in itself has no direct influence on the hemorrhage. They are, however, known to occur occasionally after clean operations.

Shock.—The methods of immediate treatment of exhaustion of the vasomotor centers and consequent fall to below normal of blood-pressure in the vessels is so well known and widely adopted that it would be superfluous to do more than to indicate the agents—adrenalin (1: 20,000 in salt solution by rectum), morphin subcutaneously, heat, rest, position, and sometimes tight bandaging of the abdomen with flannel with the idea of preventing accumulation of blood in the "splanchnic area." The use of stimulants does more harm than good. Shock is put down too often as a cause of death. It is unfortunate that autopsies cannot be obtained in more of the fatal surgical cases.

Postoperative Embolism.—Pulmonary embolism is one of the most tragic of postoperative complications. It may follow the most simple operation. It usually occurs early, 60 per cent. of the cases coming in the first week and 29 per cent. in the second week after operation. It is most frequent in patients from forty to sixty years old and is very rare in youth. The smaller emboli usually lodge in the lower lobe of the right lung. In the great majority of cases the occurrence may be attributed to the patient's condition rather than to the operative procedure. The stay of a patient in bed after operation has little to do with it, nor can infection be looked upon as a likely cause. Trendelenburg has devised an operation for the removal of the clot in the pulmonary artery. In such a condition the value of any operative procedure is most questionable.

Emboli may lodge elsewhere than in the pulmonary vessels and the magnitude of the disaster depends on the place of lodgment. I have recently had occasion to amputate the right thigh of a patient whose

uterus I had removed abdominally eight days previously. An embolus had lodged in the popliteal artery. The case was apparently a clean one.

Postoperative Phlebitis.—This is an occasional accident following aseptic abdominal or other operations. It is unavoidable and is doubtless to some degree septic. The accompanying pain, tenderness, and elevation of temperature indicate as much, though even a slight degree of infection may not be evident at the seat of primary operation. The sepsis, however, is usually of a very mild type. The second week after operation is a favorite time for its appearance.

Nutrition.—Recently the possibilities of using grape-sugar as a post-operative nutrient have been called to our attention. An easy way of obtaining grape-sugar is to pour boiling water on raisins. The resulting "raisin tea" is a valuable form of nourishment. Kausch claims excellent results in general medical work from the intravenous use of grape-sugar in solution up to 10 per cent. He begins with 1000 c.cm. of a 5 per cent. solution and gradually raises the strength up to 10 per cent. It may be repeated more often than once a day. The sugar is dissolved in salt solution, is filtered, and then sterilized. Adrenalin may be added. He advises the use of this grape-sugar intravenous injection as a means of preparing patients for operation. No dangerous sequelæ have followed its use.

No great value is now attached to the use of so-called rectal feeding (nutrient enemata) as a means of providing food. Patterson calls it "scientific starvation." Edsall has shown definitely that patients on exclusively rectal feeding absorb in twenty-four hours an amount of food only equal in value to that in a good-sized glass of milk. It is not to be denied that its psychic effect is good and that its use serves a very valuable purpose in supplying fluid to the tissues; in this way alone it often satisfies a serious demand. But it is not a tissue builder and it should not be given a higher plane than it deserves. Thus one should not use it too long as a pre-operative measure in the belief that it will greatly improve general nutrition. The value of its use is not denied, but its limitations should be kept in mind.

This brings us to the general subject of enemata, and gives us occasion to recall Soper's work on the use of the rectal tube, and his demonstration of the impossibility of giving the so-called "high enema." Only in the rare cases of abnormal development of the sigmoid is it possible to introduce a soft-rubber tube higher than 6 to 7 inches in the rectum without the tube bending or coiling on itself. It must be remembered that in spite of its name the rectum is not a "straight tube," and that its walls, except when separated by the fecal mass, are usually more or less in apposition. The soft-rubber rectal tube almost invariably coils up in the rectum. An elastic woven tube and metallic spiral sound can be passed only to the bend or apex of the sigmoid flexure. Even with a sigmoidoscope a soft tube can be made to reach only the midpoint of the sigmoid, a distance of 12 inches from the anus. All this work goes to show the futility of using the long rectal tube and the impossibility of

giving the so-called "high enema." An enema may find its way along the intestine even as far as the cecum, but one cannot carry it there. A short tube of wide caliber ($\frac{1}{2}$ inch) and from 4 to 6 inches in length is best for use in giving enemata.

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CHAPTER CXXI.

SURGERY OF THE ABDOMINAL WALL.[1]

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Plastic Surgery.—Perhaps the chief recent advance in this field has been along the lines of plastic surgery. Willard Bartlett's use of the silver wire filigree (Fig. 194, p. 435) in the cure of abdominal hernia has been so successful in his hands as to draw wide attention to it.

Fig. 195.—Coffey's Autoplastic Bandage. (Coffey, Surg., Gyn., and Obst.)

The operative procedure begins with the removal of the scar. Reducing the sac contents, separating the peritoneum and the transversalis fascia from the posterior surface of the muscles, and the placing of a ready-made filigree of No. 30 silver wire between these layers completes the

[1] Supplementary to Chapter XLVI., Vol. III., p. 726.

operation. If the defect is a large one, it will be found impossible to unite the edges of any of the overlying structures except those of the skin. Provided that the edges of the filigree are covered for a short distance, failure to unite these layers is of no importance. Because scars tend to stretch laterally, the filigree need be made up of only cross-wires held together in the middle by one single twisted strand at right angles to the others.

Coffey in 1910 added another to his valuable contributions to surgery. There is a form of relative hernia which shows itself by an increase in distance and a protrusion between the umbilicus and the

FIG. 196.—METHOD OF SUTURING THE DEEP LAYERS OF THE INCISION IN THE LINEA ALBA. (Coffey, Surg., Gyn., and Obst.)

anterior superior spinous process of the ilium. The condition may be unilateral or bilateral, is external to the recti muscles, and is due to a transverse stretching of the external oblique fascia. Coffey relieves this condition by fashioning what is really an autoplastic bandage (Fig. 195, *A*). The fascia of the external oblique is split in a direction parallel to its fibers in such a way as to converge at a point just above the symphysis, with a like split on the opposite side. After separating this fascia from the internal oblique, he draws one layer underneath the other with mattress sutures of linen which grasp the fibers of the fascia in a transverse direction. The free edge of the overlap is then sutured with catgut to the surface of the outer layer.

Even more ingenious is his scheme for increasing the space between the recti muscles in the upper abdomen. I have already remarked how nearly impossible it may be to bring the tissues of the abdominal wall into satisfactory apposition after an operation on the stomach or duodenum. Even when one is successful in closing the wound, the tension is sometimes uncomfortably great and the danger of separation of the wound edges no small one. Coffey's procedure results in an increase of 2 to 3 inches in expansion of the upper abdominal wall; the tension is thus diminished, and ease and safety of suturing is secured.

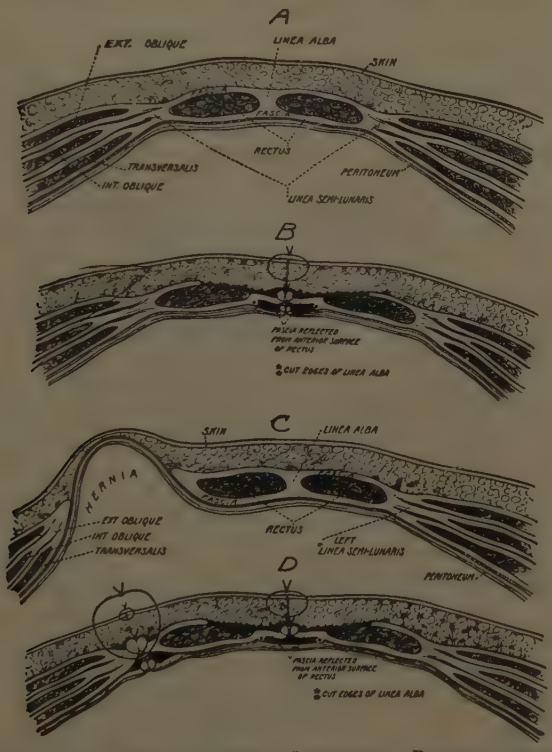

FIG. 197.—EXPANSION OF THE UPPER ABDOMEN BY REFLECTING A PORTION OF THE ANTERIOR SHEATH OF THE RECTI MUSCLES. (Coffey, Surg., Gyn., and Obst.)

A, Anatomy of the normal abdominal wall. *B*, Scheme of plastic operation for expansion of the upper abdomen. *C*, Sectional view of hernia following gall-bladder operation. *D*, Scheme of operation for closing hernia following gall-bladder operation.

The intra-abdominal operation having been completed, the anterior sheath of the rectus is incised on either side 1 inch or more from the primary operative incision (which should always be carefully placed in the linea alba when the possibility of this secondary procedure is expected) and the fascia is dissected off the muscles toward the median line. Suture the peritoneum independently of the fascia if the former is loose enough; then suture the reflected edges of the fascia together with strong catgut and the skin and subcutaneous fat with interrupted sutures (Figs. 196 and 197, *B*).

The cure of the hernia that frequently appears in the scars of gall-bladder operations usually offers a difficult problem. The possibility of artificially increasing the expansion of the upper abdomen, however, does away with much of this difficulty. Coffey thus describes his operation:

(1) Make an incision through the skin and fat from the ensiform cartilage to a point near the umbilicus, and expose the fascia thoroughly for an inch or more on each side of the median line.

(2) Make a corresponding incision of the fascia in the exact median line and thus avoid opening the sheath of either rectus. (The peritoneum is not to be opened.)

(3) Split the anterior sheaths of the recti muscles an inch or more from the median incision and dissect them off from the muscles toward the median line. Bring the edges of the fascial flaps together and suture in the median line, thus leaving a portion of the front surface of the recti muscles bare.

With the amount of expansion thus secured it is possible to close with strong fascia any hernial opening found in the neighborhood (Fig. 197, *C*, *D*).

He has demonstrated that two months after such operation a dense fibrous tissue resembling fascia had entirely covered the denuded areas of muscle.

Howard Kelly and others have operated for the relief of pendulous abdomens by excising huge wedges of the abdominal skin and fat.

Muscle transplantation has not been widely used to fill defects of the abdominal wall. Grekow has recently advocated for this purpose transplanting the sartorius muscle with its nerve- and blood-supply up over the crural ring.

Little new is at hand concerning **suppuration of the abdominal wall.** Schlosser calls attention to the appearance of chronic inflammatory tumors after herniotomies. These tumors may come on during the wound healing, shortly after, or even months and years after. They are much less frequent since the general abandonment of silk as a suture and ligature material. The cause is almost invariably a piece of infected silk. Müller and Desgouttes have put on record a case of chronic phlegmon of the space of Retzius from this cause four years after the primary herniotomy. Spellissy has published a case of abscess of the abdominal wall communicating with the bladder which contained a calculus.

Pfeiffer's article on **desmoids (fibromata) of the abdominal wall** still forms the basis of the frequent contributions on that subject. Lecène and Delamare disagree with Pfeiffer in one important particular. They believe that these tumors are not encapsulated throughout their whole extent, and that there always exists a place where they fuse with the muscles and aponeurosis, and even infiltrate and destroy them, substituting their own fibers for those of the infiltrated structures. This fact explains their frequent recurrence after removal. They are benign in that they do not cause metastases. Extirpation should not

be merely an enucleation, but rather an "enucleative resection." Fuch believes that any cause of cell proliferation may be the starting-point of such growths. Hematomata of the abdominal wall may simulate desmoid tumors.

J. P. Grant has recently reported a *primary carcinoma* of the abdominal wall in a boy of seventeen.

Lenormant divides *echinococcus cysts* of the abdominal wall into two classes, muscular and properitoneal. The former are the more fre-

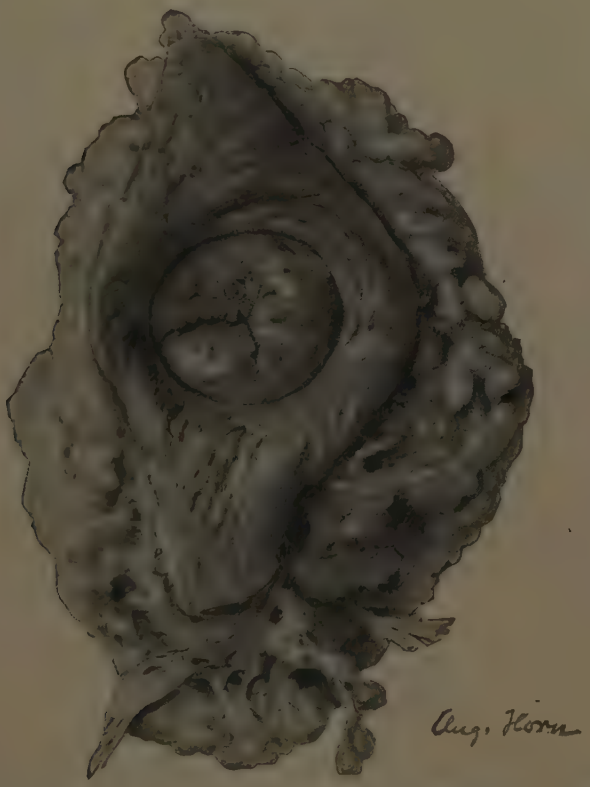

FIG. 198.—SECONDARY CARCINOMA OF UMBILICUS, NATURAL SIZE. (Cullen.)

quent. Though they are considered benign growths, complete extirpation is the operation of choice.

Diseases of the Urachus.—Weiser in 1906 reviewed 89 cases of *cyst of urachus*. Though 18 cases appeared before the fifteenth year, they are most common between the twentieth and fortieth years and are seen more frequently in women. The most common clinical feature is a slowly increasing swelling, appearing between the umbilicus and the symphysis, and varying in size from a barely palpable mass to a very large tumor. In 15 per cent. of the cases there was a discharging sinus

at the umbilicus. The usual treatment is incision and drainage. A large percentage cannot be extirpated. Of the 89 cases reviewed only 8 were treated by extirpation.

Diseases of the Umbilicus.—Malignant growths of the umbilicus and the non-malignant abnormalities due to partial or total failure of the omphalomesenteric duct to close were so thoroughly reviewed by Cullen at the 1910 meeting of the Surgical Section of the American Medical Association that I shall not hesitate to use his work in the following paragraphs.

Malignant growths may be divided into four varieties: (1) Primary squamous-celled carcinoma is very rare, the accuracy of the diagnosis of even the supposedly authentic cases being in doubt. The process is said to be a slow-growing one, and the macroscopic appearance differs in no way from that of skin cancer elsewhere. (2) Primary

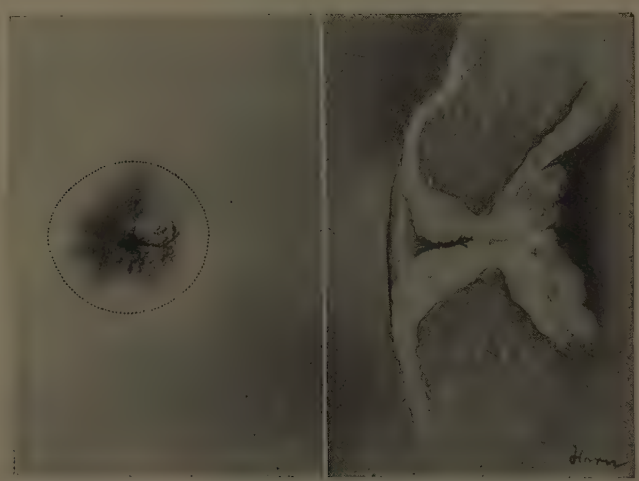

FIG. 199.—ADENOCARCINOMA OF UMBILICUS SECONDARY TO INTESTINAL CANCER. (Cullen.) Dotted line indicates limits of the induration. On the right is a longitudinal section through the umbilicus.

adenocarcinoma is uncommon. Before the growth can be designated primary, proof must be offered that it is not a secondary manifestation of a primary intra-abdominal growth. This is manifestly difficult to demonstrate with certainty. One would, however, naturally expect that malignant changes should occasionally take place in the glandular remnants of the omphalomesenteric duct, which are known to be often present at or near the umbilicus. (3) Sarcoma. Authentic cases are extremely rare. Cullen found only one in the literature which he was willing to say was "probably a sarcoma." (4) Secondary carcinoma (Fig. 198) is far the most common. The seat of the primary growth may be the stomach, the intestines (Fig. 199), the gall-bladder (Fig. 200), or the uterus and ovaries. The chief local evidence in early cases is a thickening at the umbilicus or even a small, uninflamed nodule there. Occasionally a few granular projections are

present. If such a thickening or nodule exists in a middle-aged person, a thorough investigation of the abdominal organs must be made. A history of long-continued indigestion with loss of weight and strength would lead one to suspect primary gastric cancer. An old story of recurrent attacks of colicky pain in and about the epigastric region with occasional jaundice, perhaps, would make primary cancer of the gall-bladder probable. Attacks of intestinal colic with occasional distention and increasing constipation would bring the large intestine

FIG. 200.—CARCINOMA OF UMBILICUS SECONDARY TO GALL-BLADDER CANCER. (Cullen.)
A, Appearance after removal. Natural size. *B*, A transverse section through the umbilicus.

into suspicion. A vaginal examination would tell the story of the presence or absence of trouble in the pelvic organs.

The stomach is the most frequent seat of the primary growth, and the disease travels to the under surface of the liver and thence along the lymphatics of the suspensory ligament to the umbilicus. The umbilical growth then lies extraperitoneally between the fascia and the peritoneum; the latter is rarely involved in the early stages.

The lymph-glands into which the umbilicus drains become im-

plicated only in late cases. The superficial lymphatics from the upper part of the umbilicus pass to the axillary glands; those from the lower portion, to the inguinal glands; either the retrosternal or the iliac glands receive the deep lymphatics.

Of course, it is futile to remove a secondary growth when the primary growth is elsewhere. The only possible excuse is the severe pain occasionally present in the umbilical metastasis. The decision as to whether an umbilical growth is primary or secondary can often be made only after an exploratory laparotomy has been done.

Complete or partial closure of the omphalomesenteric duct may give rise to various umbilical abnormalities. Most of these have been adequately treated in Vol. III. Attention must be called, however,

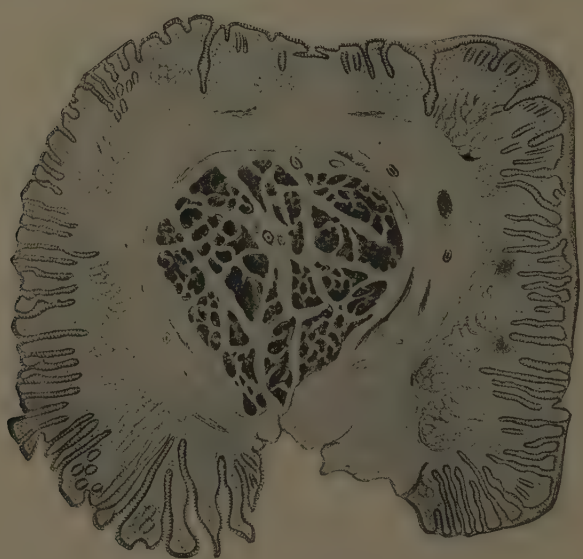

FIG. 201.—ADENOMA OF THE UMBILICUS. (Cullen.)
Transverse section. Central stem of unstriped muscle-fibers. Surrounding this a zone of fibrous tissue. Outer surface covered by what is essentially mucosa of small intestine.

to the so-called **"adenoma" of the umbilicus.** The term is a misnomer, but long use has given it its right to exist. The origin and growth of this tumor is explained by Cullen as follows:

"Sometimes shortly after the separation of the cord the umbilicus is found to be somewhat moist and the umbilical depression to be deeper than usual. Examination shows the outer half to be covered with normal skin, while the deeper portion is lined with a red, velvety mucous membrane, which, if sectioned, proves to be identical in structure with that of the intestines; it has even the subjacent layer of non-striped muscle-fiber. It is the outer portion of the omphalomesenteric duct which has remained open. Now as the umbilicus gradually closes in, the funnel of mucosa may be forced outward and turns inside out. As a result of this eversion, the inner mucous lining of the funnel becomes

the outer surface of the projection, while the muscular layer becomes its center. This condition is exactly what is found when an 'adenoma' is seen in transverse section" (Fig. 201).

Cullen is of the opinion that in the majority of instances cases reported as **dermoid cysts** of the umbilicus are really not such, but are umbilical concretions with various layers of exfoliated squamous epithelium about them. The resulting inflammation caused the gradual closure of the umbilical opening until finally a pin-point opening remained which gave exit to a purulent discharge. On picking these concretions apart small pieces of wool or hair and, occasionally, bits of stone have been found. Morestin, however, has recently reported a case under that title.

Umbilical fistulæ have provided a way of escape for round-worms and tapeworms. Gall-stones have been passed through the umbilical opening and even small hydatid cysts. Haggard has twice evacuated the exudate in a purulent peritonitis through an incision in the protruding umbilicus; this latter condition is rather common in children with much free fluid in the abdomen. In adults it is rare for the umbilicus to give way.

Muscular and Fascial Ruptures.—Kahlke in 1907 made an extensive study of muscular ruptures of the abdominal wall. By the term is meant "a dissolution of continuity in the body of a muscle due to excessive muscular activity. The accident may be associated with blunt external force or with some disease of the muscle itself which renders it more liable to rupture." Dissolution of the muscle by sharp instruments is excluded. Parturition, tetanus, coitus, vomiting, blows, jumping, lifting, injury, and attempts to avoid falling have all figured as exciting causes.

He divides ruptures into two classes: (1) Pathologic, following some pathologic change in the muscles, the rupture occurring at the diseased and degenerated point during contraction of the healthy portion; (2) functional, occurring in a healthy muscle as a result of excessive muscular activity.

A muscle is most apt to be ruptured when it enters into a movement to which it is not accustomed. The rupture always occurs when the muscle is in a state of contraction. There are three degrees: (*a*) fibrillary, probably common and often overlooked, (*b*) partial, and (*c*) total, which may be serious, but is fortunately rarely seen. Each muscle appears to have a *locus minoris resistentiæ* and usually ruptures at the same spot. The rectus, the abdominal muscle most often affected, usually gives way along the surface below the umbilicus.

The symptoms and treatment are sufficiently indicated in Vol. III.

Kahlke is of the opinion that nearly all so-called **"muscle-hernias"** are really pseudohernias due to an irregular consolidation of previously ruptured muscles.

Walther has recorded a case of rupture of the transversalis fascia by muscular contraction during violent efforts on horseback. Selby reports a traumatic case due to a fall on the handle of a wheelbarrow.

The elastic structures (skin and peritoneum) of the abdominal wall escaped uninjured, while the more rigid structures (the fascia and muscles) gave way.

Congenital Defects of the Abdominal Muscles.—There are only eight papers on this subject in all literature. Levy's review of the matter is worthy of note. The real cause of the defect is not known. It is usually observed in very young children. Levy's case, however, was in a man of seventy, and his diagnosis was carefully worked out by electric stimulation of the abdominal muscles. Henderson reports a case in a man of sixty. The resulting protrusion is usually not a true hernia, but a pseudohernia; for, as a rule, no real hernial ring is present. Levy's case, however, became strangulated. The treatment is by a binder or other mechanical support.

Contusions of the Abdomen.—Though in recent years numerous papers on the subject have appeared, I see no reason to change the conclusion that I came to some years ago after a study of a series of abdominal contusions. There is no sign or combination of signs sufficiently constant to indicate the nature of the injury or to serve as an adequate basis for definite diagnosis. In severe cases exploratory laparotomy is the only means we have for making a diagnosis in season for effective treatment. Stone agrees with this view. The mortality in cases of ruptured intestines jumps from 20 per cent., in those operated on in the first six hours after injury, to 35 per cent. in the second six hours, 56 per cent. in the third six hours, and 66 per cent. in those operated on after eighteen hours. The necessity for quick action is apparent.

Attention has been called by Zesas and by Heineke to the significance in the diagnosis of intra-abdominal injury of meteorism appearing immediately after the injury and in a few hours attaining a considerable degree. In the presence of no characteristic pain and in the absence of muscular contraction this early meteorism is said to exclude grave abdominal injury. If the latter is present, we usually see an early, more or less widespread, rapidly developing muscular contraction, and it is just this that prevents the appearance of meteorism. In mild traumatisms the muscular defense is lacking and nothing prevents the development of the meteorism. It would be very dangerous, however, to rule out severe injury on this early symptom alone. It may be safely said that primary meteorism speaks rather against than for the existence of a severe injury. Hassler notes that an abnormal localized area of tympany indicates an intestinal lesion and demands immediate operation.

Wyllys Andrews has reported a most interesting case of pneumatic rupture of the intestines by air forced in at 60 pounds pressure through the anus. He reviews 14 similar cases from the literature.

Really little attention has been given in this country to the fact that the contusing force can injure the abdominal wall without rupturing it, and can tear the vena cava, the abdominal aorta, and other large vessels without rupturing the intestines. A most interesting study of this phase of the subject has been made by Ducuing and Florence. Lack of space permits me to do no more than to mention their excellent

paper. It is difficult to admit that the enormous traumatism necessary to produce rupture of a healthy vessel could take place, except in isolated instances, without producing other intra-abdominal injury. A deficient condition of the vessel wall is the principal factor in its rupture.

Connell advises conservative treatment in **subparietal ruptures of the kidney.** This does not mean that the kidney should not be exposed in all cases of abdominal contusion followed by rigidity and hematuria. Slight lesions and complete ruptures cannot be differentiated by clinical signs and symptoms. Nephrectomy should be reserved for cases of extensive injury. Suture should be done more frequently.

It must not be forgotten that injuries to the chest may produce all signs of severe abdominal injury.

Penetrating Wounds of the Abdomen.—It is to be understood that there is a marked and necessary difference between the treatment properly given such wounds on the battlefield and in field-hospitals and that recognized as suitable for them in civil life; with the former, the chapter on Military Surgery (Vol. IV., Chap. LXVI., p. 946) deals adequately; as to the latter, the present accepted position of surgeons may be summed up as follows: Prompt operation should be the rule in all such wounds seen within the first twelve hours after the injury. A sufficiently large incision should be made to guarantee thorough inspection and to ensure ease of manipulation. Extensive evisceration is unnecessary except in rare instances of deep hemorrhage or of deep-seated injury. As a rule, irrigation is to be avoided. McRae points out that one must have a definite point of departure in examining the intestines. The first portion of intestine encountered should be brought out through the wound, and a tape or narrow strip of gauze thrown around it by pushing one end through the mesentery. A cross-nick above or below the tape will mark the point of departure. This or some similar scheme will save much time and lessen the amount of handling. Whether the intestines shall be sutured or resected, and whether the peritoneal cavity shall be drained or closed, must be left to the surgical sense of the individual operator.

In gunshot-wounds a median incision is usually the best. A transverse incision may be added without harmful effect. It is very difficult to judge the course of a bullet. In Riebel's series of 27 cases an incision over the wound of entrance would have reached the seat of damage in only two instances.

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CHAPTER CXXII.

SURGERY OF THE PERITONEUM AND THE RETRO-PERITONEAL SPACE.[1]

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The anatomy, etc., of the peritoneum was sufficiently considered in Vol. III.

Investigators are still at odds on some points relating to the **sensibility of the peritoneum.** Almost all active surgeons uphold Lennander's idea that the parietal peritoneum is very sensitive, while the visceral peritoneum, in general, is not sensitive. The interesting and important clinical observations of J. F. Mitchell lend strong support to Lennander's views, and indicate that in practical work the latter may be safely accepted as true. Propping subscribes to most of Lennander's propositions and considers them of the highest importance. Ritter, however, believes that the visceral as well as the parietal peritoneum is sensitive and experiences painful sensations. Sensibility of the visceral portion is rapidly lost when the organ is exposed to the air and allowed to dry. The painlessness of intra-abdominal manipulations is attributed to the injury of the delicate sensory nerves suffered at the time of the manipulation. Another explanation, seemingly a ridiculous one, offered for the lack of sensibility shown clinically in the visceral peritoneum is that the cocain injected into the abdominal wall produces a general analgesia.

Tumors of the Peritoneum.—Little has recently been added to our knowledge of this topic. Primary tumors are very rare and secondary rather common. Two cases of primary sarcoma were reported by Elder in 1908. The disease is of rapid growth and always ends fatally. The involvement of neighboring structures is early and rapid. Ascites is usually present and the clinical symptoms are apt to suggest tuberculous peritonitis. Cysts are occasionally found in the omentum. True serous cysts are very uncommon, and Stillman believes that they all develop from congenital cystic lymphangiomata of the omentum.

Pseudomyxoma.—This interesting condition, first described by Werth in 1884, is characterized by the production of large masses of gelatinous material, either unorganized and lying free in the peritoneal cavity or organized and firmly attached to the peritoneum. At first, all cases were ascribed to the bursting of pseudomucinous ovarian cysts and the escape of the contents into the peritoneal cavity with a resulting ("foreign-body") peritonitis. It was learned later, however, that

[1] Supplementary to Chapter XLVII., Vol. III., p. 745.

cystic appendicitis could give rise to the same condition, and now Moser and Ricker report a fatal case in a male in whom both the cecum and appendix were perfectly healthy. After a careful study the cause of the secretion was laid at the door of a chronic peritonitis resulting from an umbilical fistula that had opened into the peritoneal cavity.

According to Schumann the "foreign-body" peritonitis of certain observers, pseudomyxoma peritonei, and secondary myxoma of the peritoneum, are different stages or phases of one and the same condition.

The disease usually presents itself in women in late middle life. The patient, who may or may not know that she has had an ovarian cyst, notices a rapid enlargement of the abdomen and soon complains of abdominal pain and of pressure-symptoms. Cachexia may or may not be present. Operation discloses in many cases a ruptured pseudomucinous ovarian cyst, a peritoneal cavity full of semisolid, amber-colored masses (adherent or non-adherent), and a peritoneum covered with a very adherent, dense, grayish membrane. The appendix, if a causative factor, may be represented by a cyst. Despite repeated removal of the cysts and the colloid material, the disease recurs in many instances. Cachexia usually develops in time. Histologically the picture corresponds accurately with the processes of cancer formation, and Schumann regards it as a form of carcinoma. The prognosis is not good. Only about 50 per cent. of the cases recover. Recoveries have been reported, however, in patients who have had two or more operations. In some of the cases of appendical origin the peritoneum has been involved over a very small area, and both the appendix and the diseased area could be entirely removed with a resulting cure.

Tumors, torsion, and postoperative inflammations of the omentum do not fall within the province of this section, and are dealt with elsewhere.

Torsion of the Appendices Epiploicæ.—Briggs has made a thorough study of the subject and reviews 15 cases. The two forms—intra-abdominal and hernial—occur with about equal frequency. Varying with the locality of the affection, the symptoms may simulate those of appendicitis, gall-bladder disease, and other intra-abdominal troubles, or in the hernial sacs may give rise to all the signs of an acute strangulation or incarceration. The disease usually occurs during middle life or later in persons who are more or less obese. The affected tissue may be found free in the abdominal cavity or in a hernial sac (corpus alienum adiposum) or still attached to the intestines. It may become infected and be the cause of a peritonitis. Calcification is sometimes seen. The diagnosis is usually made only through exploratory laparotomy. Briggs considers the condition more frequent than the paucity of references in medical literature would imply.

Virchow (quoted by Riedel) has made a careful study of **corpora aliena** in all their phases.

Diseases of the Retroperitoneal Space and Glands and Retroperitoneal Tumors.—Though there is much recent literature on these subjects, nothing of importance can be added to the review of the matter in Vol. III.

PERITONITIS.

Tuberculous Peritonitis.—The surgical world has become more conservative in its views as to the benefit of operation in tuberculous peritonitis. It is generally agreed that only after patients have tried the best hygienic and therapeutic measures should operation be considered. If possible, all acute symptoms should be allowed to subside. Cures of tuberculous peritonitis by means other than surgical will increase in number with our widened knowledge of the best methods of treatment for tuberculosis in general. Operation has never been of great avail in any form of the disease except the ascitic; it has been of little or no avail in the dry, adhesive form, and is practically contra-indicated in the so-called suppurative form. Surgery has its undisputed field in dealing with the complications such as intestinal obstruction, acute perforation, etc.

When operation is undertaken for the disease itself, the extent of operation should be determined by the conditions found. The incision in women should be in the median line and in men over the appendical region, that the probable primary focus (such as the Fallopian tube, the appendix, etc.) may be attacked most readily. The primary focus should always be removed when its removal can be accomplished without too great risk of damage to the adherent intestine. Such removal will probably increase the chances of obtaining a cure, but that it is not an absolute necessity to that end is indicated by the hundreds of cases operated on and cured by simple laparotomy.

After operation, hygienic treatment should be persisted in. Lilienthal has been using old tuberculin as a supplement to surgical treatment, and believes that it is of real value. He gives a first dose of $\frac{1}{40,000}$ mg. and does not increase it sufficiently to cause a reaction.

Pneumococcus peritonitis is considered in the chapters on the Surgery of the Infectious Diseases, Vol. IV., p. 1124, and Vol. V., p. 44.

Gonorrheal peritonitis is another uncommon form. In men it is very rare. Most of the reported cases have occurred in women. In men the infection reaches the peritoneum usually by extension along the lymphatics of the spermatic cord. In women its usual path to the peritoneum is by way of the Fallopian tube, but it may extend along the lymphatics. Goodman in 1907 reviewed 75 reported cases; in only 30 was the diagnosis made certain either by autopsy or by bacterial examination. The operative mortality was slightly over 11 per cent. The symptoms are not strikingly different from those of peritonitis from other causes. The treatment is evidently operative.

Bacteria other than those already mentioned and than the common pyogenic germs may occasionally produce a primary peritonitis. A case has recently been observed at the Johns Hopkins Hospital in which the Bacillus lactis aërogenes was the proved agent.

Nothing need be added to what has already been stated on the topics of aseptic peritoneal inflammation and chronic peritonitis. Nor is it necessary to recapitulate here the sources, the symptoms, the means

of diagnosis, etc., of **acute septic peritonitis.** In fact, every word that Munro wrote on the whole subject is just as true now and just as applicable to present conditions as if it were written yesterday. His concise, comprehensive presentation of the matter is masterly, and should be carefully read.

The great mass of recent literature on the subject has to do chiefly with the treatment. There is still some confusion in designating the types of acute peritonitis, but, happily, that is growing less. The disease may well be divided into the local, the spreading, and the diffuse forms; even then we but designate different phases of the same process. This division is by no means ideal, but it is perhaps less indefinite than others. The term "general peritonitis" should be dropped. It is only in rare instances that one can say that pus is present everywhere in the peritoneal cavity. Halpenny and Gorrell put it well when they remark, "in most instances all that can be said is that the pus was (or was not) free and unconfined and present (or not) in all the operative field."

The one great essential of successful treatment is early operation. There does not, nor will there ever, exist a method of treatment that will save the life of the patient from whom operation has been too long withheld. Murphy, to whose work we owe so much of our present success in the treatment of peritonitis and whose statistics of results are remarkable, says that in cases where "the process has been going on, as a rule, from five to six days, where the abdomen is distended and peristalsis has ceased, where the hippocratic countenance is marked and the pulse is usually though not invariably rapid, while the temperature may vary from high to subnormal," he has never seen a recovery and he never expects to. Such cases are toxic, are thoroughly poisoned, are really moribund, and do not enter to any great degree into the statistics of any operator who shows a very low mortality rate. This fact should be realized by the general profession to a far greater degree than is apparent to-day. When Murphy and Deaver and others publish a long series of cases of diffuse peritonitis operated on with a mortality that is wholly or practically nil, they insist that they are not speaking of delayed cases, but of cases which have come to operation within forty-eight hours or thereabouts of the beginning of the process. The fate of these patients really lies in the hands of the practitioner who is first called to attend them. Neglect to summon the surgeon is nothing less than criminal. The mortality in the late neglected cases of peritonitis is and always will be high under any form of treatment.

On the main facts of treatment of the early cases the surgical profession is agreed. Prompt, rapid operation, careful administration of the anesthetic, removal, repair, or some method of exclusion of the point of infection, the sitting position during and some days after operation, as complete rest as possible, drainage, and proctoclysis, are the essentials. Into the details it would be superfluous to enter.

There are still a few surgeons who practice irrigation of the peritoneal cavity, and in their hands good results are obtained. The loss

of time occasioned by the use of the procedure (for, if used at all, it must be done most thoroughly), the necessarily increased amount of handling of the intestines, the danger of carrying infection to still uninfected areas, and the statistical fact of better results by simpler procedures, prevent its adoption by surgeons in general and make its general recommendation unwise.

The so-called *Ochsner treatment*, as Munro truly remarks, is, for the most part, best adapted for use in the treatment of inflammatory processes having the gall-bladder or the appendix for a focus; its employment in peritonitis secondary to strangulation, perforated ulcers, etc., is contra-indicated. Its importance as a postoperative measure is unquestioned. Its application as a primary measure is much misunderstood. Ochsner is just as enthusiastic an advocate of early operation as any other surgeon. If a surgeon is within reach, the Ochsner treatment should not be considered at all in a case of peritonitis seen in the first forty-eight hours or thereabouts. It is only to the late case, the case in the third, fourth, fifth, etc., day of the process, that even that distinguished surgeon himself would apply his method as a primary measure. There are surgeons who operate on a case of peritonitis, whatever may be its origin, as soon as they see it, whether it be in the first or in the seventh day of its course. The period of the process makes no difference. On the other hand, there are others who, meeting with the disease after its second day, do not proceed with an immediate operation, but try to assist nature in localizing the process, with the object of operating later on a localized collection of pus.

My own practice has been as follows: In the early cases, operate immediately; in the later cases, with the patient in the Fowler position, with proctoclysis in operation, with hot applications to the abdomen, institute the Ochsner treatment and start an hourly or half-hourly pulse-chart. A pulse that under these conditions shows a steady rise in rate at the end of two or three hours indicates the need of immediate operation; a steadily falling pulse-rate, on the other hand, shows that the infection is being overcome and that operation may be safely postponed. Plainly moribund cases are not subjected to operation.

Crile suggests that a culture be taken from the exudate of every case of peritonitis, so that an autogenous vaccine may be prepared, if necessary. Verbrycke has already reported a case in which an autogenous vaccine was used.

The value of the Mikulicz suggestion of instituting a hyperleukocytosis by the injection of nucleinate of soda is still undecided. De Paoli uses for the purpose a perfectly pure anhydrous salt of nucleinic acid, and claims that the disagreeable after-symptoms are less severe. The injection should be given thirty-six to forty-eight hours before the contemplated operation.

Siphonage of the stomach-contents through the nose, the introduction of salt solution into the intestine by cecostomy, by suturing a catheter into the cecum, or by an appendicostomy, the use of a current of oxygen gas introduced into the peritoneal cavity, and the employ-

ment of camphorated oil for retarding absorption, are recent measures offered by different surgeons as adjuvants in the treatment of peritonitis. There is no apparent reason for preferring any of these to the methods which experience has proved to be of value.

Kuhn has devised an ingenious method of determining the extent and even carrying out treatment of inflammatory exudates in the peritoneal cavity. For this purpose he uses long and short specula introduced through small incisions in the abdominal wall at points distant from the seat of infection and supposedly free from infection. Like urethroscopes and proctoscopes, the specula are provided with obturators and electric lamps. He claims that with these even the deepest portions of the peritoneal cavity can be easily and safely examined. It can be determined whether or not an infectious process is localized; the condition of the intestinal wall, the presence or absence of adhesions, the character and limits of an exudate, and even the necessity or non-necessity of certain operative procedures can be ascertained. Lavage of the peritoneal cavity may also be practised through one or more specula introduced through one or more incisions. The operative openings may serve as places of exit for drainage. Grooved specula or those with blades may sometimes be used with advantage. For some years Kuhn has used these instruments in the treatment of all cases of peritonitis. The usual operative procedures are, however, employed in the removal or other suitable treatment of the point of origin of the infection.

The method, while it may have some advantages, seems to present many possibilities of danger, and is not to be recommended as a routine method for general use. In the hands of its originator it has apparently given satisfactory results.

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CHAPTER CXXIII.

SURGERY OF THE ESOPHAGUS.[1]

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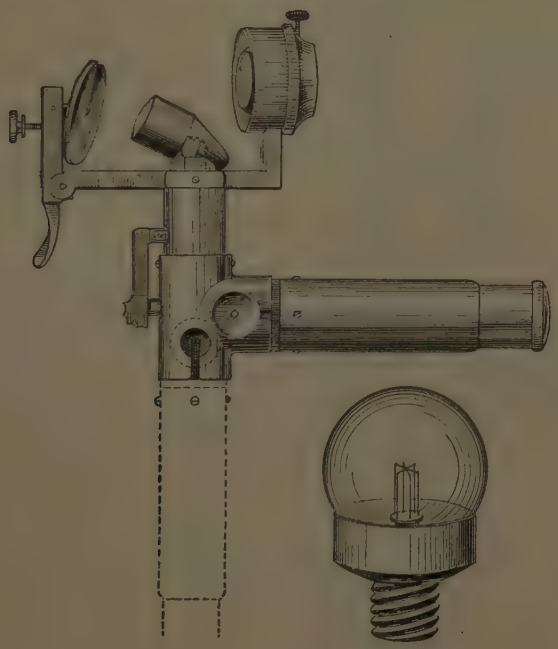
ESOPHAGOSCOPY.

The field of esophagoscopy has been quite unexpectedly extended during recent years. This is owing principally to improvements in the armamentarium by American and French as well as German and Austrian operators. In the first place, the source of light has been greatly improved. The new instruments with external illumination all



1 2

Fig. 202.—1, Kahlee's Panelectroscope. 2, Three-filament Lamp.

do excellent work. Among the best are Brünings' universal electroscope (Fig. 203), Gottstein's universal light concentrator (Fig. 204), and Kahler's panelectroscope (Fig. 202, 1). The source of light in these three panelectroscopes is a three-filament lamp (Fig. 202, 2). Brünings' pan-

[1] Supplementary to Chapter XLVIII., Vol. III., p. 780.

FIG. 203.—BRÜNINGS' PANELECTROSCOPE.

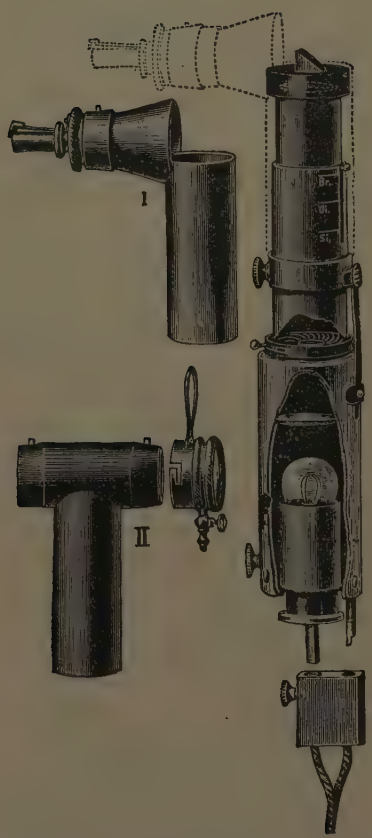


FIG. 204.—UNIVERSAL LIGHT CONCENTRATOR. (After Gottstein.)

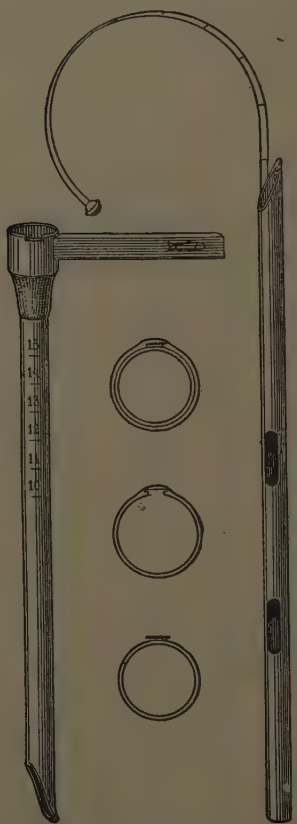


FIG. 205.—BRÜNINGS' EXTENSIBLE TUBE.

electroscope represents a combination of the old Leiter and of Casper's panelectroscopes; Kahler's is an improved modification of Leiter's instru-

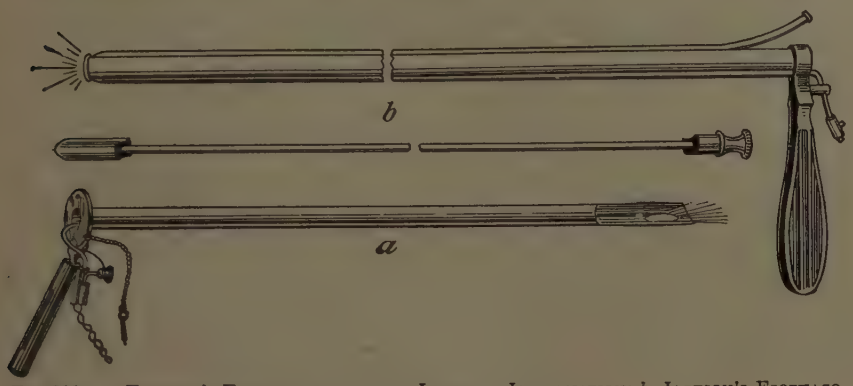


Fig. 206.—*a*, Einhorn's Esophagoscope, with Internal Illumination; *b*, Jackson's Esophagoscope, with Internal Illumination.

ment; while Gottstein modified Casper's panelectroscope by making it extensible, so as to adapt it to gullets of different calibers and by adding

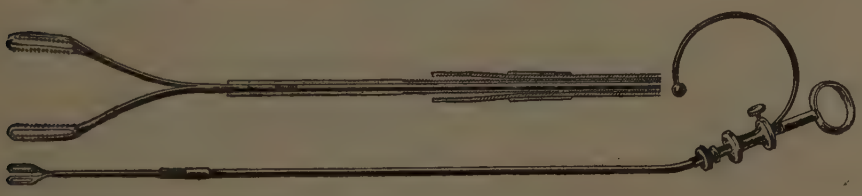


Fig. 207.—Brünings' Extensible Forceps.

an iritis-diaphragm to exclude the side rays. The esophagoscopes designed by Einhorn (Fig. 206, *a*) and Jackson (Fig. 206, *b*) work with inter-

Fig. 208.—Attachments for Brünings' Extensible Forceps.

nal illumination. Brünings' extensible tube (Fig. 205) offers many advantages. Of the many new instruments designed for therapeutic purposes,

the most important are Brünings' extensible forceps (Fig. 207), with its various attachments (Fig. 208), Lerche's (Fig. 209), and Jackson's for-

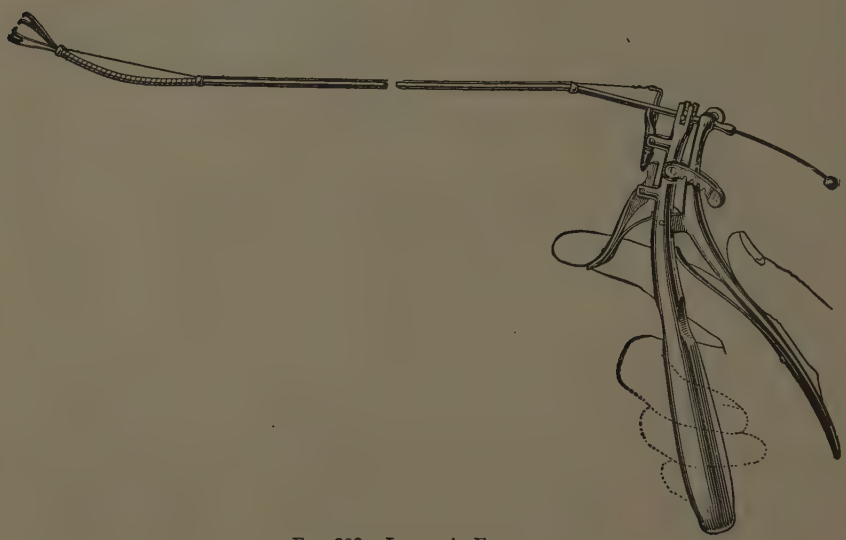


FIG. 209.—LERCHE'S FORCEPS.

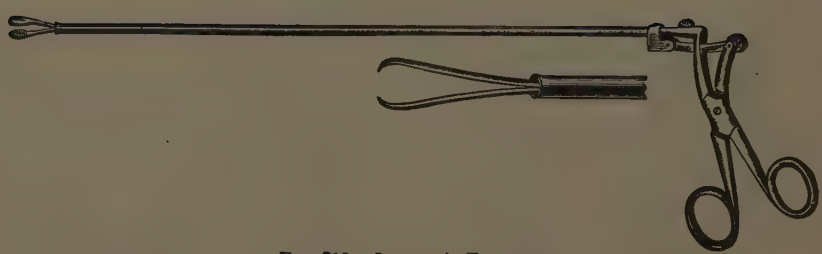


FIG. 210.—JACKSON'S FORCEPS.

ceps (Fig. 210). When the lesion is situated in the upper part of the gullet, esophagoscopy is now often carried out in the sitting posture.

FOREIGN BODIES.

External operation for the removal of foreign bodies lodged in the esophagus has been practically superseded in recent years by extraction through the esophagoscope. An extraordinarily large number of foreign bodies have been extracted in this way by von Hacker, Killian, Gottstein, and Kahler. Esophagotomy or gastrotomy was found necessary only in a few cases, and even in these the operation had usually been preceded by attempts to extract the foreign body or to pass a sound, which had caused impaction of the foreign body. Extraction of a foreign body through the esophagoscope is simplified by a preliminary application of adrenalin to the mucous membrane immediately surrounding the foreign body, an important procedure that should never be neglected. A great many instruments for extracting foreign bodies have been brought forward, but for most cases Gottstein's forceps, the

jaws protected by rubber tubing, will be found to answer every purpose. If the examination is followed by subcutaneous emphysema, indicating a probable perforation of the esophagus, or if a mediastinal abscess is revealed by the esophagoscope, the gullet should be at once exposed by a mediastinotomy through the neck (*mediastinotomia collaris*), and tamponed, but not opened. In this way Gottstein avoided an otherwise certainly fatal termination in 2 cases.

PULSION DIVERTICULA.

Killian's work on the "Pharyngeal Opening of Esophagus" has placed the doctrine of pulsion diverticula on a new basis. He demonstrated the existence of an esophageal cardia analogous to the cardiac orifice of the stomach, situated at the junction of the pharynx and the esophagus. By means of hypopharyngoscopy the esophageal cardia can be seen quite dis-

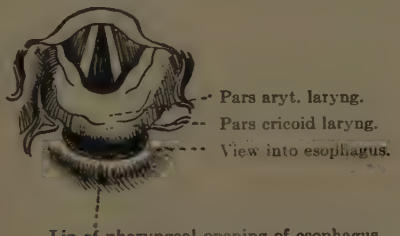


FIG. 211.—VIEW OF ESOPHAGUS IN HYPOPHARYNGOSCOPY. (After Killian.)

tinctly (Fig. 211) lying behind the cricoid cartilage. The cricopharyngeal muscle (inferior constrictor of the pharynx) may be divided into a *pars obliqua* and a *pars fundiformis* (Fig. 212); the latter forms the esophageal cardia. While cardiospasm produces a diffuse dilatation of the entire esophagus, the dilatation in cases of spasm of the esophageal cardia is limited to the weakest portion of the tube, the posterior wall

FIG. 212.—ANATOMY OF THE REGION OF THE ESOPHAGEAL CARDIA. (After Killian.)

between the *pars obliqua* and the *pars fundiformis* (Fig. 213), because the esophagus is supported in front by the cartilages of the larynx, and on each side by the two lobes of the thyroid gland. This affords a simple explanation of the development of pulsion diverticula. During

recent years Lotheisen's non-operative method of dilating the esophageal cardia at the diverticulum by means of an inflatable rubber bulb has been repeatedly employed. Gottstein obtained good results in 3 cases of small diverticulum by this method, combined with the use of a sound, shown in Fig. 214. The effect is analogous to that produced by dilat-

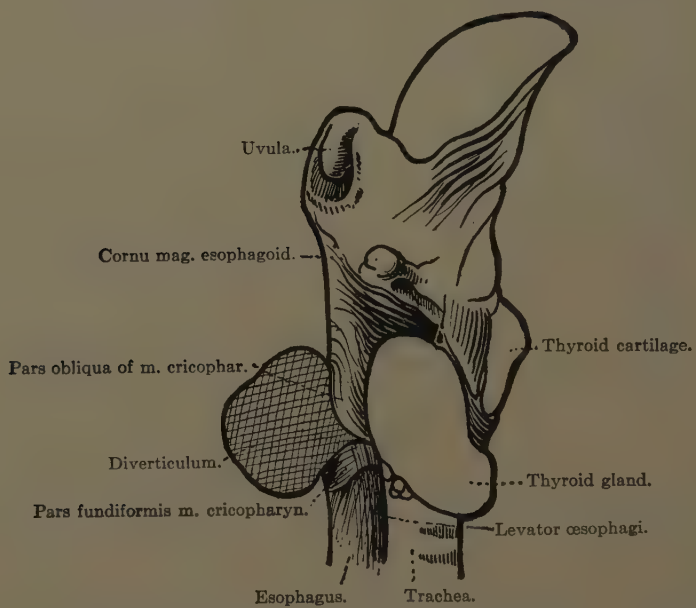


FIG. 213.—POSITION OF PULSION DIVERTICULUM OF ESOPHAGUS. (After Killian.)

ing the cardia, namely, stretching of the muscle—in this case the muscle of the esophageal cardia. The dilatation must be done carefully, using air rather than water, because the position of the diverticulum behind the larynx is prone to induce an attack of asphyxia.

The number of operations performed for the correction of pulsion diverticula has very much increased during the last few years. While

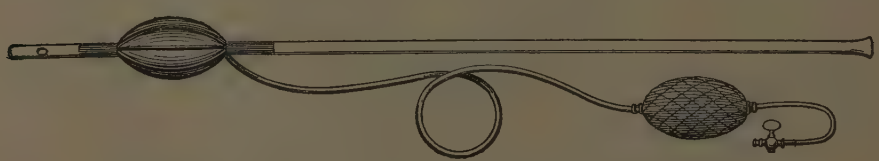


FIG. 214.—GOTTSTEIN'S DILATING SOUND FOR PULSION DIVERTICULUM.

in 1906 44 cases were published, the list at present numbers 70, with only 8 deaths. The total average mortality is, therefore, more than 11 per cent., but has a much lower percentage during the last three or four years, as most of the deaths occurred more than about four years ago. The most popular operation consists in the introduction of sutures in three layers, with tamponade of the medi-

astinum. Goldmann recently recommended that the operation be performed in two stages: at the first operation the sac is ligated at the base with silk and the tip secured with sutures in the upper angle of the wound. Extirpation is not performed until one week later, in order to avoid infection of the mediastinum by esophageal secretions. This method appears to be suitable only for small diverticula; if the sac is large, ligation may easily cause distortion or angulation of the esophagus. The after-treatment is facilitated by a preliminary gastrostomy, or by instituting rectal feeding during the first three to five days.

CARDIOSPASM.

The treatment of cardiospasm has made considerable progress during the last few years. The operative procedure, after von Mikulicz, has been almost entirely abandoned in favor of dilatation, after Gott-

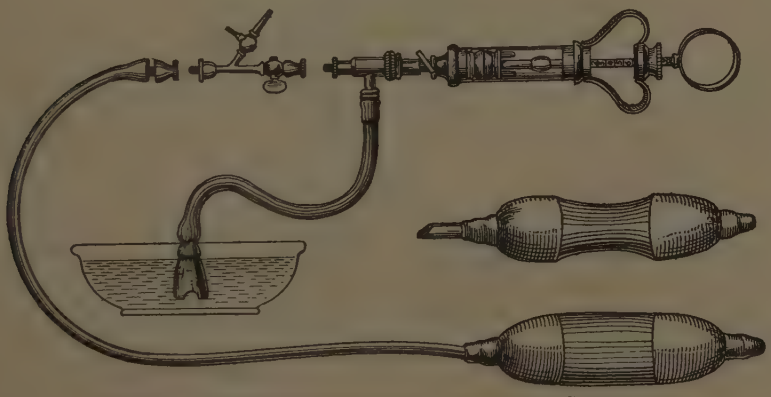


Fig. 215.—Gottstein's Dilating Sound for Chronic Cardiospasm.

stein. For dilatation of the cardia Geissler designed a sound containing a tube of webbing between two rubber tubes. This has not proved to be a serviceable instrument in practice, as it is apt to slip into the

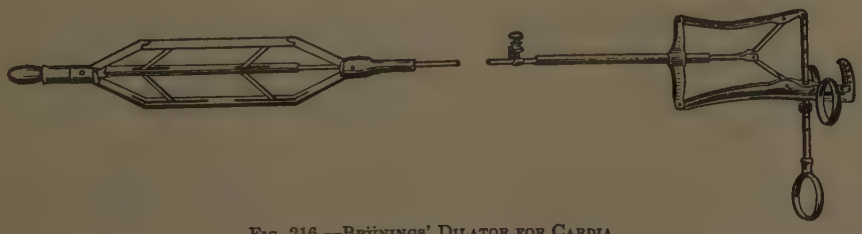


Fig. 216.—Brünings' Dilator for Cardia.

esophagus or into the stomach during dilatation. Gottstein modified it by adding a constriction at the middle and thus rendered the method practicable. The bulb is filled with water and can be gradually dis-

The German "*M*undwinkel" is presumably a typist's error, it should be "*W*undwinkel."

tended to 12 or 14 cm. (Fig. 217). Excellent results have been obtained in this way. Up to 1908 Gottstein treated 6 cases, and since then 8 more, with brilliant therapeutic results. Some of the patients

Fig. 217.—Gottstein's Dilating sound for Chronic Cardiospasm.

put on as much as 70 pounds during the year following the operation. Other successful cases are reported by Wilms, Graff, Erdmann, Wendel,

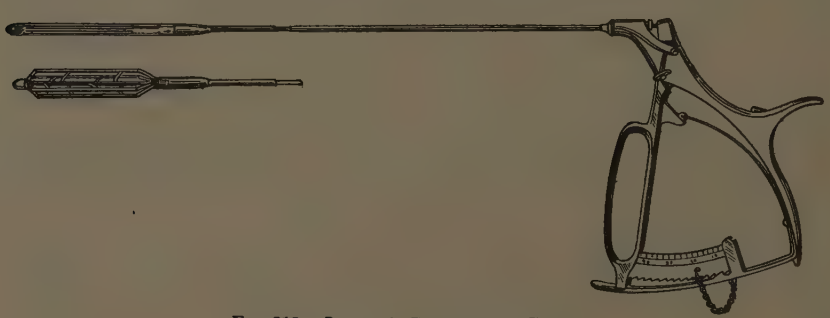


Fig. 218.—Lerche's Dilator for Cardia.

Bonsdorff, and Makkas. This dilating sound is introduced in the same way as any other sound.

Dilatation through the esophagoscope has been recently attempted. Instruments have been constructed by Brünings (Fig. 216) and Lerche

(Fig. 218), who also report complete recoveries obtained by their use. von Mikulicz's operation is now limited to cases in which it is found impossible to pass the dilating sound through the cardia.

ARTIFICIAL SUBSTITUTES FOR THE ESOPHAGUS.

Three different methods have been tried during the last few years in attempts to produce an artificial esophagus. The first (Gluck) consists in performing a preliminary external esophagotomy and a gastrostomy, and connecting the two fistulous openings by a rubber tube, through which the food is carried from the mouth to the stomach. Gluck and Perthés each performed this operation in 1 case. Perthés' patient, a six-year-old boy with an impermeable stricture caused by swallowing lye, was able to take bread and meat, as well as liquids, after the operation.

A second method was proposed by Wullstein in 1904, and in 1907 E. Bircher reported 2 similar operations by H. Bircher. Bircher makes two vertical incisions from the left submaxillary region to the costal arch, forming a strip of skin on the sternum a little to the left of the median line. The edges, having been undermined for 1 to 2 cm., are then united by shotted sutures in front, and a tube lined with epidermis is thus produced. The distal edges of the two incisions are then united over this new tube, so that the artificial canal is completely covered with skin. It was intended later to attach the upper end of the tube with sutures to an esophageal, and the lower to a gastric, fistula. Both patients died before the union between the cutaneous canal and the fistulous openings could be completed, the cause of death being pulmonary embolism and perforation of the esophageal cancer into the lung.

FIG. 219.—ROUX'S ESOPHAGOJEJUNOGASTROSTOMY.
Isolating loop of jejunum.

The third, and most promising operation, first performed by Roux, of Lausanne, in 1907, consists in transplanting a portion of jejunum under the skin of the chest wall. Roux resects a piece of sufficient length from the jejunum (Figs. 219 and 220) which, owing to its peculiar blood-

supply through straight vessels (*vasa recta*), can be successfully isolated. The aboral (distal) extremity is fastened to a gastric fistula, while the oral (proximal) end is brought out through the abdominal wound (Fig. 220). Through a vertical incision a little to the left of the episternal notch the skin of the chest wall is tunneled by a dressing forceps (Fig. 221), and the segment of jejunum drawn through the tunnel with dressing forceps introduced from above (Figs. 222 and 223). The end of the segment is later united to the esophagostomy opening. Roux operated for the first time on a boy six years old, who was provisionally fed through a funnel introduced into the artificial esophagus.

FIG. 220.—ROUX'S ESOPHAGOGASTROJEJUNOSTOMY.
Implantation of aboral (distal) end of jejunum into anterior wall of stomach.

Wullstein had recommended this operation as early as 1904, with the modification of drawing the section of jejunum through the gastrocolic ligament in order to avoid pressure on the transverse colon. Herzen operated in this way for the first time in 1908 on a girl twenty years old, and obtained a complete recovery; the patient is now taking bread, scraped meat, and eggs by mouth. The advantage of using the jejunum for the artificial esophagus lies in the fact that it possesses peristaltic movements, which in Herzen's case could be distinctly seen at every mouthful. It is not certain, however, that the nutrition of the excised

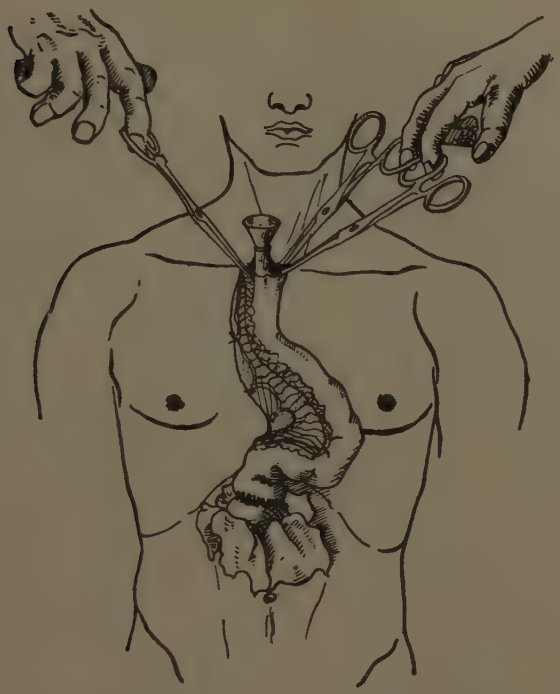


FIG. 221.—ROUX'S ESOPHAGOJEJUNOGASTROSTOMY.
Placing the loop on the chest wall to determine the length.

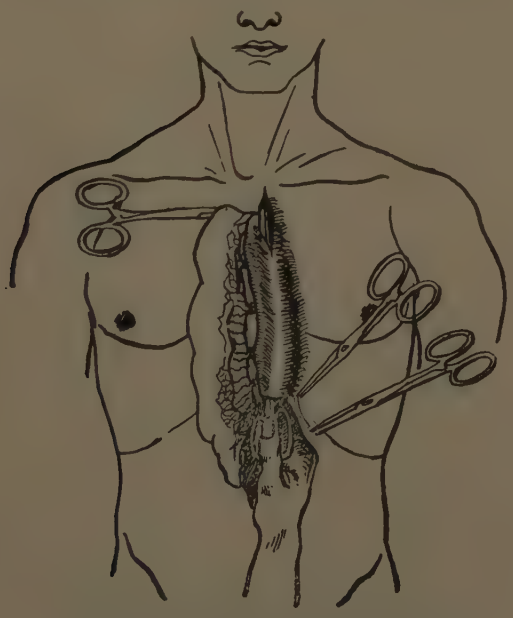


FIG. 222.—ROUX'S ESOPHAGOJEJUNOGASTROSTOMY.
Tunneling the skin of the chest wall.

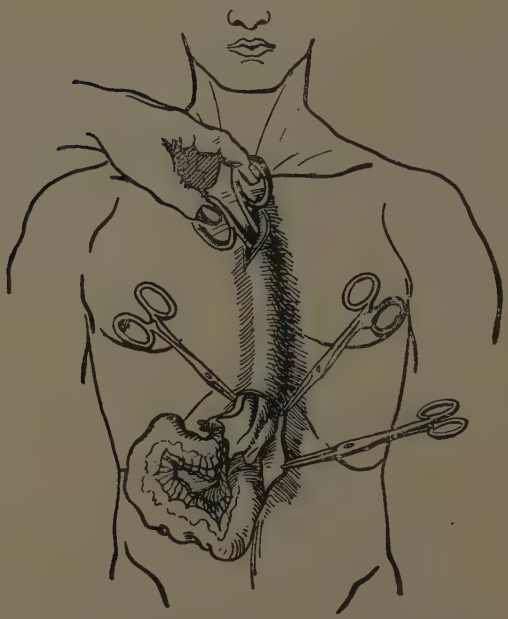


FIG. 223.—ROUX'S ESOPHAGOJEJUNOGASTROSTOMY.
Drawing the loop of jejunum through the skin funnel.

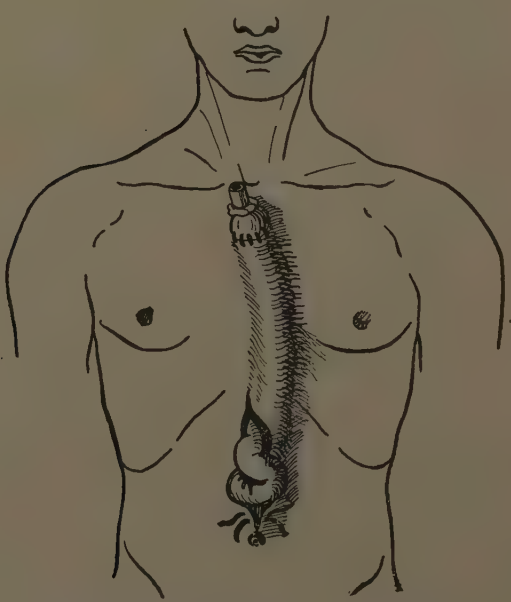


FIG. 224.—ROUX'S ESOPHAGOJEJUNOGASTROSTOMY.
The loop of jejunum fixed in position under the skin.

piece of jejunum would prove sufficient in all cases. Kocher observed necrosis in the case of an elderly individual. Roux's and Herzen's patients were under thirty. In 1909 Rydygier reported a case in which death occurred from bronchopneumonia before the second part of the operation was performed, five weeks after the first. Rydygier agrees with Roux that the operation should be performed in two stages, with a preliminary gastrostomy. In 1911 Kelling, of Dresden, utilized the transverse colon for an artificial esophagus, but it was found to be too short, and for this and other reasons also the operation is not to be recommended.

OPERATIONS ON THE ESOPHAGUS IN SAUERBRUCH'S CABINET.

Resection and anastomosis of the esophagus in a Sauerbruch cabinet, which four years ago were quite novel operative procedures, have been further elaborated during recent years. Although the results so far obtained in human surgery are anything but encouraging, it is to be hoped that by perfecting the technic of these operations we shall soon be enabled by their means to secure radical cures.

There are three difficult problems in intrathoracic surgery of the esophagus: The danger of pneumothorax. The low resistance of the pleura to infection. The technical difficulty of uniting the two esophageal extremities, or the esophagus with the stomach.

The comparative merits of positive and negative pressure have been discussed in Vol. III., p. 559, and in Vol. VI., p. 953. The danger of pneumothorax can be entirely eliminated by operating either under positive or under negative pressure; but infection of the pleura can be avoided only by the most scrupulous asepsis and by selecting those procedures which make it possible to resect without opening an infected cavity. [See also Vol. VI., pp. 968–973 (Meltzer's chapter), and Vol. VI., pp. 395–399 (Brewer's chapter), for Esophageal Operations under Insufflation Anesthesia.—W. W. K.]

The greatest difficulty is encountered in securing absolutely safe union of the esophageal extremities after resection.

Indications for Resection of the Esophagus.—According to Sauerbruch, the only absolutely favorable cases are those of carcinoma of the cardiac portion in the initial stage; relatively favorable are the neoplasms situated from 3 to 5 cm. above the cardia, and those situated from 18 to 22 cm. below the teeth. In all others the radical operation is for the present contraindicated on account of the technical difficulties. A necessary condition for the operation is that the tumor be easily isolatable. This must be determined not by clinical methods, nor by Röntgenography or esophagoscopy, but solely by an exploratory thoracotomy, which, like exploratory laparotomy during the early period of abdominal surgery, needs to be employed oftener than is now the case. A stenosis of the esophagus should never be subjected to operation unless the diagnosis of cancer has been previously confirmed by excising a portion of the tumor for microscopic examination.

Resection of the Cardia (after Sauerbruch and Tiegel).—After it has been determined by a preliminary exploratory thoracotomy that the tumor can be readily isolated, the adhesions are separated, the tendinous portion of the diaphragm divided down to the *hiatus œsophagi*, and the trunks of the pneumogastric nerves isolated. If, on account of adhesions, injury of these nerves is unavoidable, the nerves must be smoothly divided. A rubber tube is now passed around the esophagus and traction made to put it on a stretch (Fig. 225). A cone of stomach

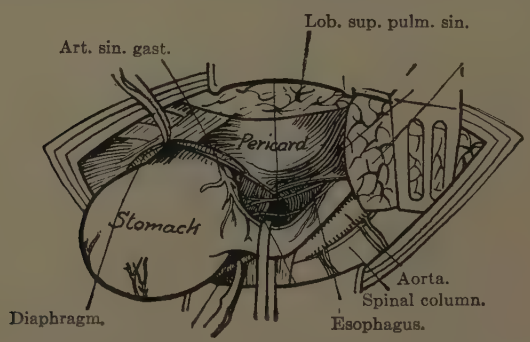


FIG. 225.—RESECTION OF THE CARDIA IN SAUERBRUCH'S CABINET. (After Sauerbruch.) Showing method of making traction upon the esophagus with a rubber tube after it has been isolated.

wall is drawn into the thorax and the stomach mobilized by dividing the lesser omentum in layers. The remaining steps of the operation may be performed in one of two ways:

(*a*) **Invagination Method in Two Stages.**—A glove-finger-shaped invagination is made in the stomach wall, thereby eliminating the possibility of infection of the thoracic cavity from the esophagus. At the end of one to two weeks the invaginated cone is amputated

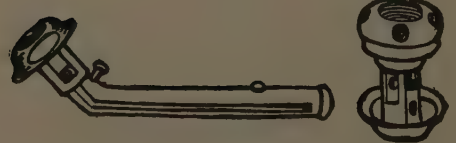


FIG. 226.—TIEGEL'S ESOPHAGOGASTROSTOMY BUTTON.

FIG. 227.—TIEGEL'S ESOPHAGOGASTROSTOMY BUTTON IN SITU.

through a gastrotomy opening, followed immediately by closure of the abdominal cavity. This operation is possible only with small tumors of the cardia.

(*b*) **One Stage Operation with Primary Union of Esophagus and Stomach.**—In this method sutures are uncertain, and a button, such as those designed by Payr and by Tiegel (Figs. 226 and 227), which are very serviceable, is to be preferred. The button is introduced into the

esophagus before the operation, the tube simply tied off, and after a clamp has been applied, divided (Fig. 228). The stomach is then divided, and sutures accurately placed in two layers. A small cone of stomach wall is then picked up, a small opening made, and the button, which is fastened to the esophagus, inserted. Two purse-string

FIG. 228.—RESECTION OF THE TUMOR AFTER CLAMPS HAVE BEEN APPLIED TO ESOPHAGUS AND STOMACH. (After Tiegel.)
Drawing up a cone of stomach wall for the purpose of making the button anastomosis.

FIG. 229.—SECURING THE STUMP OF THE STOMACH WITH ACCURATELY PLACED SUTURES. (After Sauerbruch.)
Introduction of the esophageal button after a double purse-string suture has been placed.

sutures, previously introduced one above the other, are then drawn together and tied, after invaginating the end of the esophagus (Fig. 229). The cardiac end of the stomach is now fixed in the thoracic cavity by suturing both edges of the diaphragm accurately around the stomach (Fig. 230).

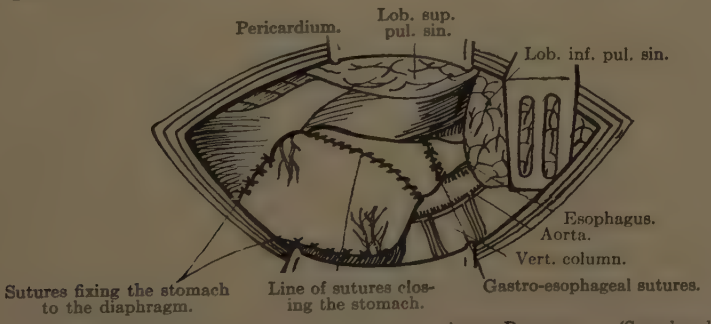


FIG. 230.—COMPLETE ESOPHAGOGASTROSTOMY AFTER RESECTION. (Sauerbruch.)
The two edges of the diaphragm are accurately sutured to the stomach.

As yet no radical cure has been effected by resection of the esophagus. Sauerbruch is the only operator who has had patients survive resection—1 five days, 1 eight days, and 1 two weeks. The operation has been performed so far by von Mikulicz, 5 cases; Anschütz, 1; Sauerbruch, 10; Tuffier, 3; Wendel, 2; Küttner, 6; W. Meyer, Tiegel, and Kümmel, each 1 case. Küttner and Schmieden strongly recommend the two-

stage operation. Exploratory thoracotomy has been frequently performed with good results (von Mikulicz, Sauerbruch, Friedrich, Küttner, Schmieden, and W. Meyer).

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CHAPTER CXXIV.

THE SURGERY OF THE STOMACH.[1]

By A. W. Mayo Robson, F.R.C.S.,

London.

GASTROJEJUNAL AND JEJUNAL ULCER.[2]

One of the most serious complications of gastro-enterostomy is jejunal or gastrojejunal ulcer, the former being wholly in the jejunum, the latter at the margin of the gastro-enterostomy opening.

Figure 231 shows a gastrojejunal ulcer, the result of an infected hematoma.

Mayo believes that the greater number if not all gastrojejunal ulcers are due to technical failures in the operation of gastro-enterostomy, whereas true jejunal ulcers may be unavoidable.

In the Mayo clinic, out of 1141 gastro-enterostomies, so far as could be ascertained, there had been no case of pure jejunal, though there had been an operative experience of three gastrojejunal, ulcers: (1) The result of an impacted Murphy button, causing symptoms three years and nine months after operation, the button having been retained in the stomach. The ulcer was excised and another operation performed over a Mayo-Robson's bone bobbin, the patient making a good recovery. (2) The result of retention of infected suture, occurring seven months after operation. The ulcer was excised and another gastro-enterostomy performed, the patient making a good recovery. (3) The result of an infected hematoma in the suture line. The whole of the opening including the ulcer was excised two and a half years later and Finney's operation performed.

It would seem from a study of reported cases that no one type of gastro-enterostomy renders the patient immune from this form of ulcer.

My own view of the cause is that sufficient care is not exercised in dieting patients who have undergone the operation of gastro-enterostomy, and that hyperchlorhydria and sepsis combine to produce the ulceration.

The Mayo type of the posterior no-loop operation appears to be the one least likely to be followed by jejunal or gastrojejunal ulcer.

In order to prevent this complication, absorbable material should only be used for the marginal sutures, and the after-care of the patients from a dietary point of view should receive more attention. The

[1] Supplementary to Chapter XLIX., Vol. III., p. 825.

[2] In Vol. III., p. 901, the subject has already been considered.

danger arises not only from pain and recurrence of symptoms of ulcer, but also from the fear of perforation. The danger of perforation is greater after posterior than after anterior gastro-enterostomy, as in the latter omental adhesions frequently tend to prevent direct perforation into the peritoneal cavity.

A valuable paper on this subject was published by Herbert J. Paterson,[1] in which he refers to 2 cases of his own and to 61 recorded cases. He recommends that the anastomotic opening should be carefully examined, and if small it should be enlarged or a new gastro-

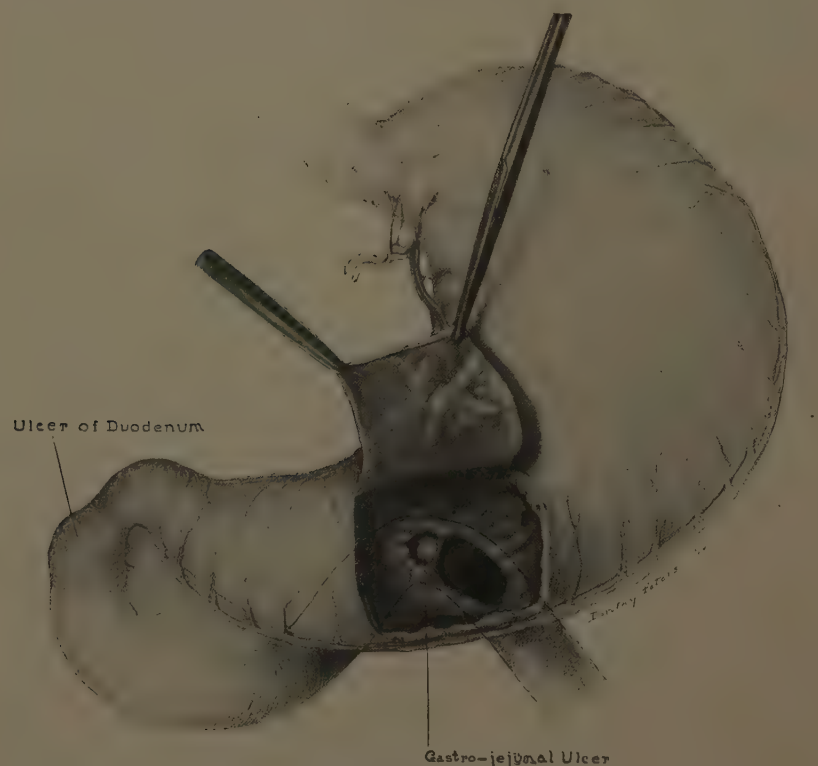

FIG. 231.—GASTROJEJUNAL ULCER, THE RESULT OF INFECTED HEMATOMA. (Mayo.)

jejunostomy performed. In case of recurrence he advises a modification of Roux's operation by implanting the proximal limb of the jejunum into the stomach, so that the alkaline bile and pancreatic fluids may be diverted into the stomach.

I consider that the special form of operation necessary for any case can only be decided on when the abdomen is opened and the condition of the diseased parts ascertained.

If jejunal or gastrojejunal ulcer has been diagnosed by a renewal of gastric symptoms at some interval after the operation of gastro-

[1] Proc. Royal Soc. Medicine, June, 1909.

enterostomy, and the case fails to yield to general treatment, the only course open to the surgeon is to perform abdominal section and thoroughly to examine the jejunum at or near the point of anastomosis.

If the diagnosis is confirmed there are three courses open:

(1) If the ulceration is at the gastrojejunal anastomosis and the original ulcer at the pylorus or in the duodenum is healed, the jejunum may be detached from the stomach, the ulcerated area excised, and the openings in the stomach and jejunum closed. This I have performed successfully on three occasions.

(2) If the pyloric or duodenal ulcers in healing have led to stenosis, a new gastro-enterostomy may be performed, either by selecting another convenient site on the posterior wall of the stomach and performing Roux's operation, or by doing an anterior gastro-enterostomy after Roux's method.

(3) If the ulceration is jejunal, the diseased part of the jejunum may be excised and, according to the healthy condition or otherwise of the duodenum and pylorus, the healthy jejunum may be united end to end, or a new gastro-enterostomy may be performed at a fresh site by Roux's method.

The operation of jejunal excision I have adopted successfully on three occasions.

SO-CALLED CHOLELITHIC AND APPENDICULAR DYSPEPSIA.

The frequent association of cholelithiasis with gastric symptoms has been well known for many years, and as Graham has recorded:[1] "The sudden, irregular, mild dyspeptic attacks are quite as typical of gall-bladder disturbance as are the severe typical attacks which, as a rule, supplant the mild."

There are the mild attacks characterized by flatulency soon after food, discomfort or even pains of short duration, passing off without special treatment or after eructation of wind or perhaps slight vomiting, and there are the more severe seizures equally sudden and equally irregular, but lasting longer and accompanied by more pain and marked tenderness in the epigastrium or in the right hypochondrium. The pain is increased by food and exercise, and may be affected by respiration so as to resemble a pleurisy. A feeling of nausea or even sickness leading to vomiting may be present.

The irregularity of the attacks, the sequence of a slight icteric tinge in the conjunctiva, and the almost universal presence of a tender spot on pressure midway between the umbilicus and the right costal margin, usually enable the disease to be distinguished from gastric ulcer.

In chronic appendicitis the symptoms may altogether resemble gastric trouble, the pain being above the umbilicus, worse after food, and sometimes accompanied by vomiting, occasionally even of blood. There is usually absence of fever or swelling in the region of the appendix, and some physicians aver that there is no tenderness or rigidity over the cecum. With the latter observation I cannot concur, as I

[1] Jour. Minnesota State Med. Assoc., April 1, 1910.

have usually found tenderness at McBurney's point and some rigidity of the recti at one time or another; moreover, the symptoms are more irregular, not occurring every day or at the same time after food, and rarely is any temporary relief given by the taking of food, as so often is the case in genuine ulcer of the stomach.

The grouping of the symptoms may point so strongly to organic disease of the stomach or duodenum that it is of the utmost importance to bear the appendix in mind, both in the diagnosis and treatment of all gastric affections.

When operation is decided on, it should also be remembered that the discovery of a diseased appendix does not exclude the possibility of co-existing stomach trouble, nor that the discovery of ulcer of the stomach or duodenum demanding operation does not exclude the presence of a chronic appendicitis, which without attention might keep up gastric symptoms.

Although many surgeons have recognized the frequency with which chronic appendicular disease is associated with gastric symptoms, the profession is indebted to Wm. J. Mayo for drawing particular attention to it. A valuable paper on Appendix Dyspepsia was also written by B. G. A. Moynihan.[1]

It is interesting to note that an examination of the appendices removed in association with gastric and duodenal ulcers and with so-called pyloric spasms by W. C. MacCarty and Bernard F. McGrath shows that there is a higher percentage of appendices with partially or completely obliterated lumen in these conditions than among general autopsies or even in operations for appendicitis.[2]

This raises the question of the possibility of an etiologic relationship between the appendix and pathologic conditions in the stomach, duodenum, bile-passages, and pancreas, which they think may be explained on the lines of development and blood and nerve supply.

Other articles bearing on this subject worth referring to are—an address by Moynihan[3] on "Correlation of Symptoms and Signs in Some Abdominal Diseases," and a paper by Axel Borbjaerg[4] on "Stomach Symptoms in Intestinal Disease."

Personally, I think a more likely explanation is the influence of pathogenic bacteria, which, occupying the gastro-intestinal canal, not only produce characteristic pathologic lesions there, but invade the channels leading out of the intestine, and thus lead to appendical, biliary, and pancreatic troubles.

ACTINOMYCOSIS OF STOMACH.

In abdominal actinomycosis it may be difficult to determine the organ originally affected, hence, though the stomach has been obviously involved in several cases of abdominal actinomycosis, the extent of the

[1] Brit. Med. Jour., Jan. 19, 1910.
[2] Annals of Surg., 1910.
[3] Brit. Med. Jour., Feb. 17, 1912.
[4] Ugeskrift for Læger, Oct. 19, 1911.

disease has usually rendered it impossible to say that the gastric affection was primary.

In the case mentioned below, on which I operated in December, 1910, there was no record of the patient's having chewed straw or swallowed anything that might give rise to disease, nor was there any evidence pointing to the primary involvement of any other organ than the stomach.

The following is the report of the case that came under my care:

Mrs. W., aged sixty, was well up to January, 1910, when she began to suffer from pain and discomfort in the upper abdomen and to lose flesh; her appetite was very poor and she is reported to have suffered from indigestion. Pain was not a prominent symptom and did not bear any very definite relation to food. In May a tumor was discovered in the epigastrium, after which the loss of flesh became more rapid. When I saw her in November the epigastrium was occupied by a tumor extending across the middle line on both sides, but the bulk of the swelling was on the left, extending upward beneath the left costal arch. The skin over the tumor was thickened and edematous, and the abdominal swelling appeared to be adherent to the anterior abdominal wall. On giving soda-water to inflate the stomach, a resonant area corresponding to the stomach appeared in front of the main part of the tumor. An examination of the blood and urine revealed nothing abnormal. The temperature had been normal throughout the illness. On December 6, 1910, a vertical incision was made a little to the right of the middle line. The abdominal wall was found to be much thickened and edematous, and no distinction could be made between muscle and fascia. On dissecting carefully downward an abscess-cavity was opened containing about a teaspoonful of thick, creamy pus. This cavity was scraped out and purified, and a further dissection was made and a larger cavity opened, which proved to be the stomach, there being no distinction between the tissues of the viscus and the abdominal wall. The cavity was drained until the following day, the wound being closed quite up to the tube. An examination of the pus showed the presence of mycelium of actinomyces. The day after operation the stomach-drain was removed and the patient was fed by rectum. Potassium iodid was administered in the rectal injections. Gastric juice drained through the sinus, which gradually closed and the wound healed completely. The patient left the nursing home relieved and certainly looking better, but, although general treatment was carried out subsequently and the patient was able to take food, she gradually failed, and died May 6, 1911, five months after operation.

In over 50 per cent. of cases of abdominal actinomycosis the cecum is the part first attacked.

Grill says that of 77 abdominal cases treated surgically, 45 died, 22 recovered, and 10 were improved.

Frazier (See Vol. I., p. 524) states that the mortality in abdominal actinomycosis in the United States has been 71 per cent. of all cases collected.

GASTROPTOSIS.

Illustrations of Eve's operation for gastroptosis were given in the original chapter on Gastric Surgery, Vol. III., p. 839.

Up to March 1, 1910, Eve had operated on 20 consecutive cases of well-marked gastroptosis. In 11 cases performed by his own method, he reports satisfactory results.

Return of displacement does not occur, for he has examined his cases at considerable intervals after operation, and never found the greater curvature of the stomach at a lower level than two finger-breadths below the costal margin in the left nipple line.

He concludes that gastro-enterostomy should if possible be avoided in these cases, and should only be performed in gastroptosis with dilatation and atony and when hematemesis is associated.

The operation is performed as follows: A sand-bag is placed beneath the lower thorax, as for operations on the liver; the abdomen is opened to the left of the middle line, and the liver well raised and held up by an assistant, the lesser omentum being thus fully exposed. If the thorax is very long and narrow, a head lamp is advisable. The stomach is suspended by four or five interrupted silk sutures, passed above through the upper part of the gastrohepatic omentum and below through the lesser curvature. Advantage is taken of the fact that the gastrohepatic omentum close to its attachment to the diaphragm and transverse fissure of the liver is much thicker than lower down; but if the whole membrane is equally thin the sutures are passed above through the liver itself, just anterior to the transverse fissure. This is rarely necessary. Below, the sutures are carried through the serous and muscular coats, just in front of the attachment of the lesser omentum, the vessels, of course, being avoided. The suture furthest on the right is not placed quite up to the pylorus, in order that when the sutures are tied the pyloric end of the lesser curvature may be on a slightly lower level than the portion on the cardiac side. A very long needle-holder is required in passing the sutures above under the diaphragm.

EXCISION OF CHRONIC ULCERS OF THE STOMACH.

The origin of cancer from gastric ulcer is only another instance added to many of which we have knowledge of the effect of persisting irritation in establishing malignant changes.

Wm. J. Mayo[1] says: "In connection with gastrojejunostomy, if an ulcer exists in the stomach it should be excised if possible." Excision gets rid of the disease and prevents a possible secondary cancerous degeneration. In no less than 59.3 per cent. of cases of cancer of the stomach on which I have operated, the history pointed strongly to ulcer as the primary cause.

L. B. Wilson and W. C. MacCarty, as the result of numerous observations on specimens or autopsies from the Rochester Clinic,[2]

[1] Surg., Gyn., and Obst., May, 1908.
[2] Amer. Jour. Med. Sci., Dec., 1909.

all of which had been carefully microscoped and photographed to illustrate the paper, state that "the reports on specimens removed at operation during the last decade have practically settled the question as to the very frequent occurrence of gastric carcinoma on the site of previous ulcer."

For ulcers lying in the pyloric end of the stomach, Rodman's operation of partial gastrectomy, with complete closure of the duodenum and stump of the stomach and an independent gastrojejunostomy, is the most efficient procedure. This operation is really an application of the well-known Billroth operation to a new purpose, and is capable of giving excellent results.

FIG. 232.—TRANSGASTRIC EXCISION OF CALLOUSED ULCER OF THE POSTERIOR WALL OF THE BODY OF THE STOMACH, SHOWING ANTERIOR WALL OF THE STOMACH OPEN AND THE ULCER EXPOSED. THE DOTTED LINES SHOW PROPOSED SITE OF EXCISION. (Mayo.)

In "saddle" ulcers of the lesser curvature and in ulcers of the anterior stomach wall, resection can be readily carried out. The scar of an ulcer causing hour-glass contraction can be best removed by partial gastrectomy of the ulcerated segment and end-to-end union.

There are, however, a number of chronic ulcers of the posterior stomach wall much more difficult to deal with, and for these Wm. J. Mayo has succeeded in making a transgastric excision of the ulcer through an incision in the anterior stomach wall. He has performed the transgastric operation for removal of adherent calloused ulcers of the posterior wall of the body of the stomach five times, without leakage or evidences of infection, and with the recovery of the patient in each instance. The steps of the operations are as follows:

The gastrohepatic and gastrocolic omenta are opened above and below the ulcer. Gauze protection is introduced, adhesions are carefully separated, and, if possible, the surface of the ulcer is cut free from the posterior attachments without opening the stomach. A piece of gauze is packed into the denuded area behind, and in all but one of the cases this temporary pack was adequate to stop hemorrhage without the ligation of vessels. The anterior wall of the stomach is opened, and with the fingers behind, the entire ulcerated surface is pressed

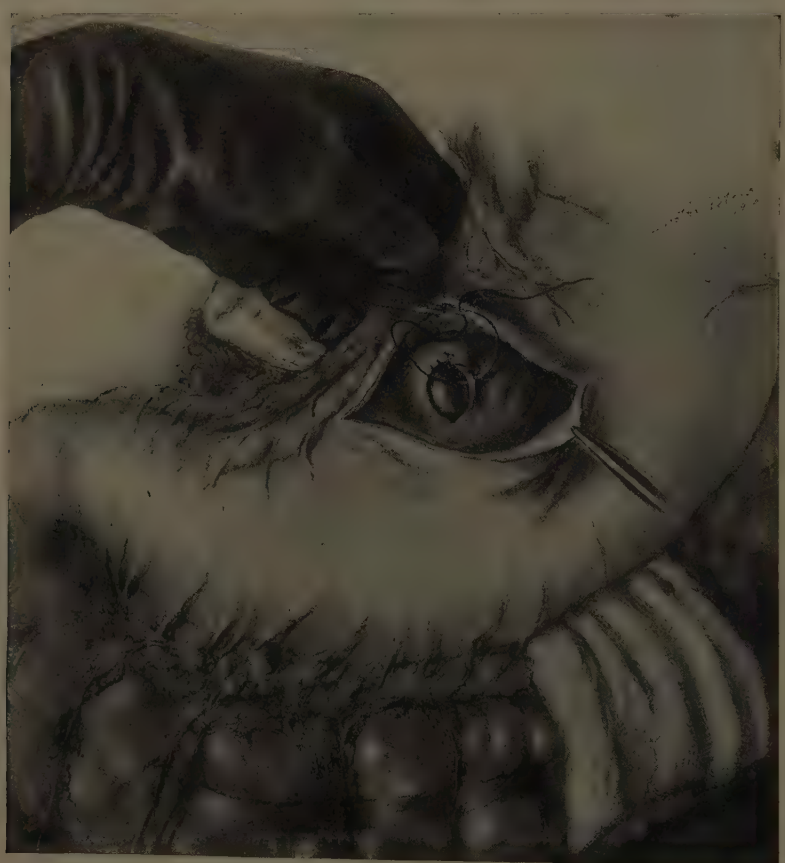

FIG. 233.—ULCER EXCISED, AND THE THROUGH-AND-THROUGH MUCOUS SUTURE PARTIALLY COMPLETED. (Mayo.)

through the anterior incision and the ulcer excised (Fig. 232). The gap is sutured with through-and-through sutures of chromic catgut from the mucous side transversely, and this suture line is further protected by several mattress sutures of linen, applied from the mucous side to prevent separation due to the early absorption of the catgut (Fig. 233). The anterior wall of the stomach is then closed. Several rubber-tissue drains are carried down behind the stomach and brought out at the upper end of the abdominal wound as a safeguard (Fig. 234).

Lewis Pilcher in May, 1907, made a transgastric excision of the posterior wall of the stomach in a similar manner, with a successful

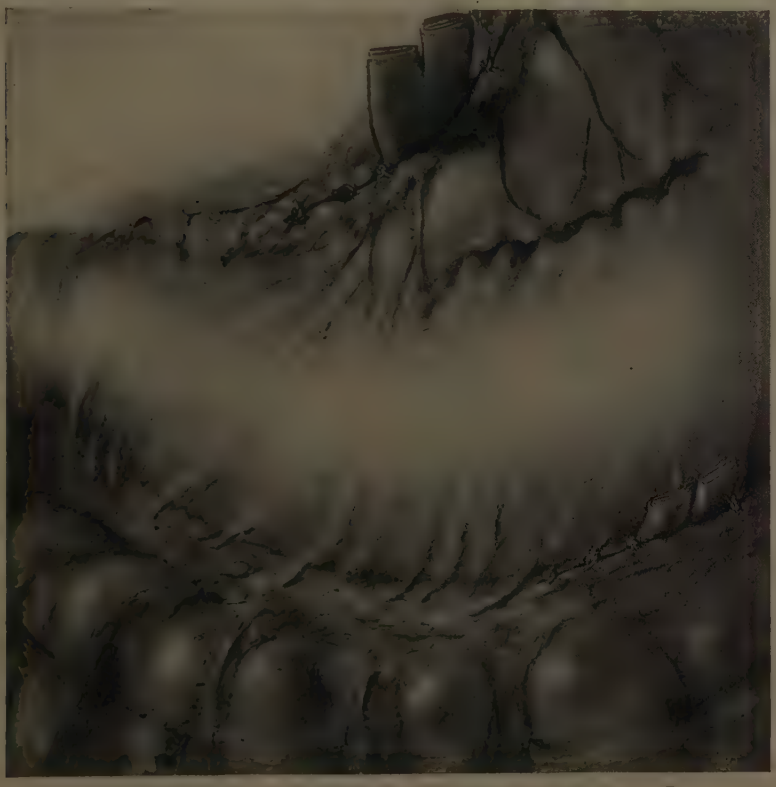

FIG. 234.—ANTERIOR WALL OF THE STOMACH SUTURED. RUBBER-TISSUE DRAINS IN PLACE. (Mayo.)

outcome. A report of the case was published in the Long Island Med. Jour., May, 1908, p. 187.

Figures 232, 233, and 234 illustrate Wm. J. Mayo's paper.

DILATATION OF THE PYLORUS IN PYLOROSPASM.

Einhorn recently made attempts to stretch the pylorus by the introduction of specially constructed instruments (pylorodilators) (Fig. 235). He did it once in a case of congenital stenosis of the pylorus in an infant six weeks old and twice in spasmodic contraction of the pylorus in adults. The history of the case of congenital stenosis of the pylorus is as follows:

Ezra P. L——, aged seven weeks, was well until two weeks after birth. He then began to vomit after every meal. At the same time he became weaker and was constipated. He weighed 10 pounds at first and $7\frac{3}{4}$ pounds when five weeks old.

Present state: Stomach dilated, greater curvature extending to one finger below the navel. Vomits after every feeding. Two to three hours after nursing the stomach is found to contain a considerable quantity of coagulated milk. The stomach was washed out twice, but the symptoms continued. A diagnosis of con-

genital stenosis of the pylorus and consequent dilatation of the stomach was made by several clinicians, including myself.

A miniature duodenal bucket was twice introduced and left in the digestive apparatus of the infant for four and six hours respectively. In withdrawing the bucket it was found that it did not pass the pylorus. I then introduced a tiny piece of a perforated olive-shaped metal (3 mm. diameter and 6 mm. long) on a silk thread and left it in the digestive canal for six hours. In drawing the thread upward a resistance was encountered, which appeared to show that the olive had passed the pylorus and was lodged within the duodenum. Over the thread I then introduced an inflatable catheter which on reaching the duodenum was filled with air by means of a glass syringe. In withdrawing the dilating catheter a distinct resistance was encountered at the pylorus, but the same was overcome with the application of some force. Within the stomach no resistance was felt until the cardia was reached. At this point the air was liberated and the instrument easily withdrawn, also the thread with the olive.

The infant began to retain its feedings and to pick up. It gained a half-pound within two weeks. Later, however, the vomiting re-appeared. One month after the first stretching of the pylorus the same procedure was repeated with good results.

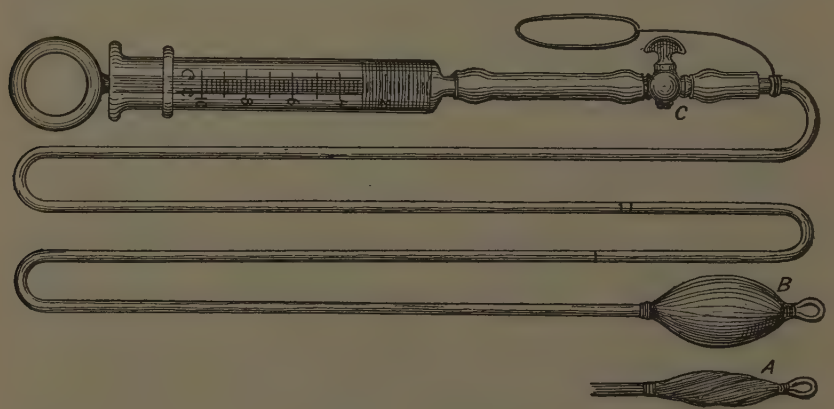

FIG. 235.—EINHORN'S PYLORIC DILATOR.

A, Rubber bag with gauze envelope in collapsed shape; *B*, rubber bag with gauze envelope when inflated with air; *C*, stop-cock.

This mode of treatment may, Dr. Einhorn thinks, find application in specially selected cases, principally of pylorospasm due to gastric ulcer or to remote reflexes.

THE THREAD TEST FOR THE RECOGNITION OF ULCERS OF THE UPPER DIGESTIVE TRACT.

Einhorn[1] described a method which he states permits us to recognize and to localize ulcers along the upper digestive tract (esophagus, cardia, lesser curvature of the stomach, pylorus, duodenum). The method consists in having the patient swallow at night before retiring the duodenal bucket with a braided silk thread attached, and removing it the following morning in the fasting condition. The thread is fastened in such a manner that it can travel for a distance of 75 cm. from the teeth.

A distinctly brownish discoloration on the thread, due to blood, signifies the presence of ulceration. The distance of this spot from the lips marks its location.

[1] Med. Record, April 3, 1909.

Figures 236 and 237 illustrate the result of the thread test in ulcers of the different regions of the digestive tract.

The author states that rarely does it occur that the duodenal bucket shows an impregnation mark of blood in persons who do not present the usual symptoms of ulcer. It is then difficult to decide whether the blood-stain be due to an exaggerated pulling of the thread from the duodenum over a normal or slightly congested mucosa of the stomach or over an ulcer.

Gross[1] regards the use of Einhorn's bucket and thread test as unreliable in duodenal ulcer, and advocates instead the use of his duodenal tube with its little silver ball.

THE USE OF THE DUODENAL BUCKET FOR DIFFERENTIATING BETWEEN STRICTURE AND SPASM OF THE PYLORUS

Einhorn[2] states that the duodenal bucket has been of great assistance in differentiating between a real stricture of the pylorus and a

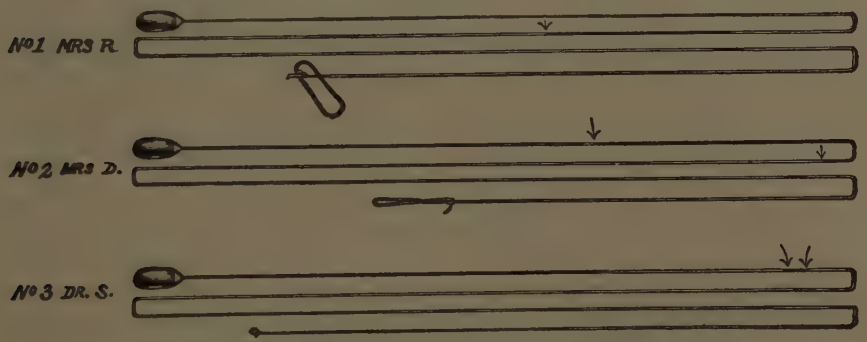

FIG. 236.—THE DUODENAL BUCKET WITH THREAD AND BLOOD-STAINS.

The arrow shows the position of the reddish-brown spot. No. 1, Red spot from 35–39 cm.; No. 2, trace of brown discoloration from 41–54 cm.; No. 3, reddish-brown from 50–51 cm.

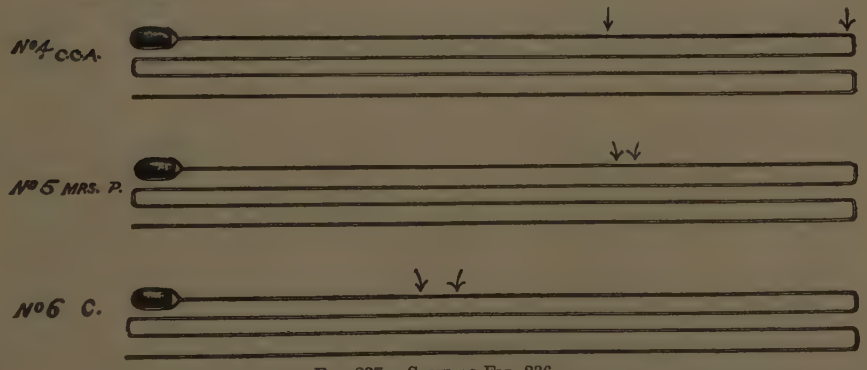

FIG. 237.—SAME AS FIG. 236.

No. 4, Reddish-brown spot from 47–53 cm.; No. 5, brownish discoloration at 60 cm.; No. 6, brownish discoloration at 62 cm.

spastic condition of this organ. If the bucket was found to have passed the pylorus, as may be recognized by first feeling a slight resistance in

[1] Med. Record, April 22, 1911. [2] Illinois Med. Jour., June, 1910.

withdrawing the bucket through the duodenum and pylorus; second, by the contents of the bucket, which, if from the duodenum, show a golden-yellow or greenish color from admixture of bile and often an alkaline reaction; third, by the thread showing a golden-yellow color from the bucket upward for about 10 to 15 cm. (the part of thread which was beyond the pylorus), while the rest of the thread remains unstained, then it is known that no real stricture exists, and we must ascribe this condition rather to a spastic form of contraction of the pylorus. If, however, the bucket did not pass the pylorus, then it was known that as yet a spastic condition could not be excluded, unless the experiment has been repeated quite frequently.

ENDOSCOPIC EXAMINATION OF THE STOMACH.

1. **Direct Vision Esophagogastroscopy.**—To Kussmaul belongs the merit of having first attempted to make an endoscopic examination of the stomach per "vias naturales." In a lecture published in 1868 he described his observations on a tolerant patient, a "sword-swallower," the interior of whose stomach he demonstrated to the Freiburg Society of Naturalists by means of a straight gastroscopic tube 47 cm. long and 13 mm. in diameter; the illumination, however, was too feeble for the method to be of much practical use. Killian was more successful with this method thirty years later, as the employment of the Kirstein head lamp provided better illumination. Chevalier Jackson in 1905 substituted a terminal small metallic filament lamp for the proximal source of light; he used tubes 70 and 80 cm. long. In an illustrated monograph published in 1907 Jackson gave colored drawings of a large number of observations on normal and pathologic stomachs. This method of direct vision is suitable enough for the examination of the region of the cardia, but in the collapsed empty stomach there is always danger of traumatism in ulcerated conditions, and it is rarely possible with a long narrow open tube to make anything like a complete survey of the gastric interior. William Hill recently (1910) modified Killian's instrument by adding a plain glass slanting window at the proximal end of the endoscope, together with a tap, for purposes of inflation; by means of this instrument the stomach can be more efficiently and more safely directly inspected when fully inflated with air. It is obvious, however, that a direct vision endoscope, with a small field of vision not much larger than a threepenny bit (10 cent coin), must be very inferior to an indirect vision periscopic apparatus on the principle of the cystoscope with a large field of the dimension of half a crown (half a dollar).

2. **Indirect Vision Gastroscopy.**—After Nitze had perfected his cystoscope he turned his attention in 1879 to endoscopy of the stomach, but while he recognized that the stomach should be accessible to endoscopic examination, he assumed, in spite of Kussmaul's experience, that a rigid straight gastroscope could not be passed, and he, therefore, constructed a jointed instrument which could be inserted in a flexible con-

dition and afterward straightened. The illumination, however, was apparently so poor that a satisfactory inspection of the inflated stomach was never achieved by Nitze's periscope.

In 1881 Mikulicz was more successful in actually obtaining very fair views of the interior of the inflated stomach by means of a rigid indirect optical apparatus. He discarded the straight tube, however; his gastoscope was a rigid periscope 65 cm. long and 14 mm. in diameter bent at an angle of 150 degrees at the junction of the middle and distal thirds. This bend in the instrument Mikulicz thought necessary on account of the projection of the lower dorsal vertebræ, and to enable the part containing the terminal prism to project comfortably forward into the stomach. This method of gastroscopy failed to conform to endoscopic requirements in an essential particular, viz., the instrument was passed blindly, guided by touch instead of under vision throughout; and on account of fatal perforations occurring this method soon became obsolete, though it has been recently (1909) resuscitated by Souttar and Theodore Thompson, who have also had mishaps.

In 1895 Rosenheim employed a straight gastroscope made up of an optical tube and of an inflating and illuminating tube enclosed in an outer straight metallic sheath. If this outer metallic tube had been passed through the gullet into the stomach under direct vision by means of proximal illumination, Rosenheim would have solved the problem of safe and efficient gastroscopy by a combination of the direct and indirect vision methods; but not being an esophagoscopist, he stuck to the faulty, blind method of introducing his rigid straight tube. Rosenheim's gastroscope has not been extensively used, for gastrologists shrank from pushing a rigid tube into the stomach, and we find that in 1896 Kelling and Küttner returned to the principle of the jointed gastroscope as originally employed by Nitze. Kelling's instrument was introduced in a flexible condition and then rendered rigid by an ingenious mechanism, and made to assume the same shape as the Mikulicz gastroscope, that is to say, its lower third was at an angle. This beak of Kelling's instrument was so constructed that the terminal prismatic window could be made to revolve. In 1897 an important improvement in Rosenheim's method was made by Rewidzoff; for the outer metallic tube he substituted a flexible gum elastic sheath; this was first blindly passed into the stomach and the right periscopic tube afterward inserted through it. Kausch, of Berlin, has recently employed a gastroscope constructed by Lowenstein on this principle.

Loening and Stieda have substituted an India-rubber outer tube, which is first passed blindly by the aid of a mandrin. With these later instruments, once they have been inserted into the stomach without mishap, an excellent exploration of the gastric interior (with the exception of the cardia) can be made; their only shortcoming is that they cannot be passed under direct vision through the esophagus and cardia, in fact, they are purely gastroscopes and not esophagogastroscopes. Loening and Stieda's published results form the most important contribution to gastroscopic findings which had then appeared.

3. **Combined Direct and Indirect Vision Esophagogastroscopy.**—In 1909 William Hill pointed out that the ideal gastroscope ought to include an outer straight metallic endoscopic tube which should first be passed into the stomach under direct vision, and the optical tube could then be safely inserted through it. The demand for this combination of the direct and indirect vision methods seems sufficiently obvious, and it is remarkable that it has taken over forty years to evolve a really

FIG. 238.—DIAGRAM TO SHOW THE PASSAGE OF HILL'S DIRECT VISION INFLATING ESOPH'AGOGASTROSCOPE THROUGH THE PHRENOCARDIAC PORTION OF THE GULLET WITH THE AID OF BRÜNINGS' HAND-LAMP.

FIGS. 239 and 240.—THE HILL-HERSCHELL METHOD OF ESOPHAGOGASTROSCOPY.

Fig. 239 shows the straightening of the spine in examining the upper part of the gastric cavity in the sitting position.

Fig. 240 shows the forward protrusion of the neck and thorax in examining the lower portion of the interior of the stomach, including the pyloric antrum.

acceptable method of gastroscopy. The apparatus devised by Hill, in conjunction with Herschell, consists essentially, as will be seen by reference to the accompanying illustrations, of combining Killian's direct vision esophagogastroscope (as modified for inflation by Hill) with the straight indirect periscopic tube similar to that made for Loening by Heynemann, of Leipsig. A gastroscope on the same principle, but differing in detail, has recently been brought out independently by Foramitti, of Vienna.

Technic.—The technic of the passage of the outer indirect vision tube is practically identical with that of direct esophagoscopy. The patient, if tolerant, can be examined in the upright position under cocain anesthesia, but for prolonged examinations the dorsal position on a table is preferable; most serious work, however, demands general anesthesia, chloroform being the anesthetic of choice unless the patient is very debilitated and suffers from a weak heart, when C. E. mixture or ether *by the open method* is indicated.

An injection of morphin and scopolamin twenty minutes before the examination serves to prevent excessive secretion and reduces the amount of anesthetic necessary. If the patient has had no food for twelve hours it will rarely be found necessary to resort to lavage of the stomach. If, however, food residues are found present in passing the direct vision endoscope, the viscus can be easily washed out through it with a rubber tube attached to Sonoran's aspirator. No fluid must be left in the stomach, for, as Herschel has pointed out, when inflation is commenced this will be churned up into froth, which will partially obscure the view.

The outer tube of the esophagogastroscope is passed under direct vision by the aid of either Brünings' hand lamp or of Kirstein's head lamp, and the region of the cardia is then examined under inflation.

Before passing the inner optical tube the window and the hand lamp are removed, and a handle can be substituted for the latter and the perforated cap takes the place of the glass window; the optical tube is now inserted through the cap and the outer tube, but inflation should be commenced before the end of the former reaches the stomach in order to prevent contact with the mucosa, which may soil the window of the periscope and obscure vision.

The first thing to do on insertion of the optical tube is to localize the fold at the upper margin of the entrance to the pyloric antrum which appears as a very prominent landmark; with this as a starting-point the pyloric canal and pylorus should be first inspected. The rest of the stomach can then be explored by gradually withdrawing and orientating the gastroscope until the cardiac orifice is reached, when the light appears to go out; this region, together with the subphrenic portion of the esophagus, can only be inspected by means of the direct vision outer tube, *i. e.*, by direct esophagogastroscopy. With a *fully* inflated stomach the rugæ and convolutions of the mucosa almost completely disappear; with moderate inflation, however, these are plainly visible. Blood-vessels, more especially engorged veins, form a prominent feature in cases of portal congestion, but usually the blood-vessels are not very marked, except along the lesser curvature. Multiple hemorrhagic erosions (gastrotaxis), definite chronic peptic ulcers, malignant growths with or without ulceration, hour-glass constrictions, and pyloric stenosis can be readily recognized when the gastroscope is in the stomach, even by those who have had little experience in endoscopic examinations and interpretations.

The chief difficulty experienced by the beginner is in moving the

end of the instrument so that the window is an inch or so from the anterior or from the posterior wall, or from the anterior curvature on the right and the greater curvature and fundus on the left. This change of position of the tip of the instrument is an anteroposterior plane and in a lateral plane is accomplished by manipulating the spine, *e. g.*, by raising or lowering the shoulder-blades or by bending the dorsal spine laterally to the right or left; but these manipulations can readily be learned with a little practice. Movements due to beating of the heart and of the aorta, and to respiration, more especially from contraction of the diaphragm, do not materially interfere with the view in a moderately inflated stomach, but air distention does not altogether abolish the peristaltic contractions of the viscus, and in moderate inflation the pyloric canal can readily be seen to close up and then open; it is only in the latter phase that the pyloric orifice can be seen; as the window of the gastroscope is usually nearly 3 inches from the pyloric opening the latter is much diminished in the picture, and is seen as a black round hole about the size of the top of a lead pencil.

Lower or Laparogastroscopy.—Examination of the interior of the stomach through a gastrotomy orifice has been employed by Roosing, of Helsingfors, and others; a cystoscope can be used after the stomach has been filled with water. A better view of the region of the cardia is obtained by this method than by any other, but it cannot have any wide application in surgery. It has been employed mostly for purposes of anatomic and physiologic study, and has served to confirm the observations made by upper gastroscopy "per vias naturales."

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GASTRIC SKIAGRAPHY.

Skiagraphy, in its recent applications, affords one of the most important aids in the diagnosis of gastric diseases, and in defining exactly the shape, position, and movements of the stomach. (See p. 1008.)

RELATIONS OF THE MESOCOLIC BAND TO GASTRO-ENTEROSTOMY.

Wm. J. Mayo[1] has pointed out the variability of the peritoneal reflection over the ligament of Treitz, and the desirability of trimming this reflection back to expose the origin of the jejunum in the operation of gastro-enterostomy.

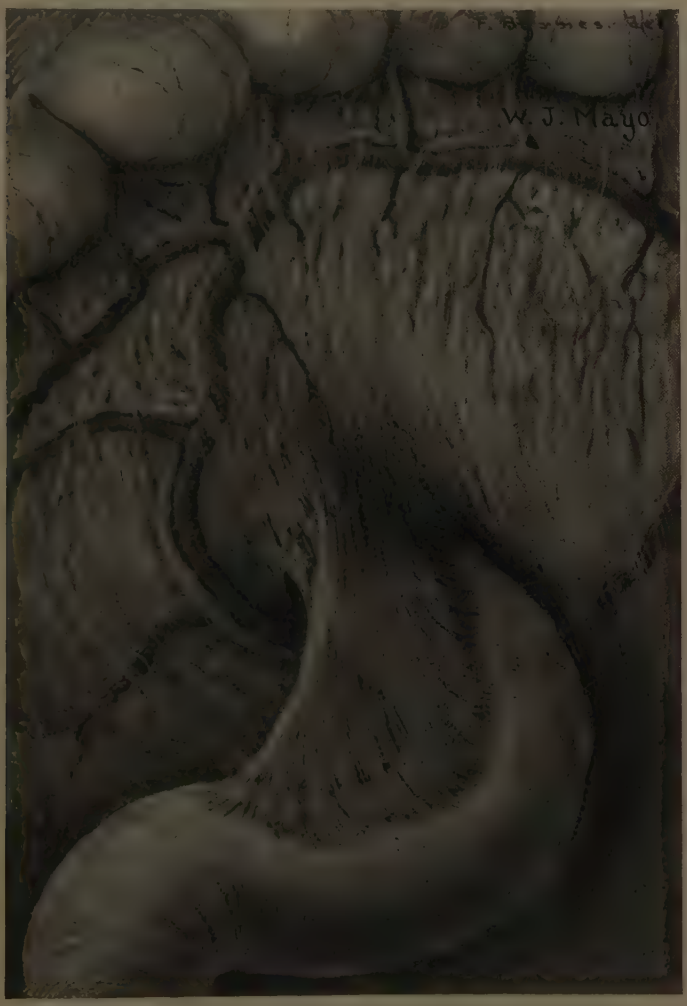

FIG. 241.—SHOWING EXTENSIVE PERITONEAL FOLD WHICH TURNS THE INTESTINE TO THE RIGHT. (Mayo.)

Figs. 241 and 242 show the position of the jejunum before and after the trimming, and how the denuded surface of the jejunum may be utilized to apply to the posterior surface of the stomach through the vascular space in the mesocolon on the left of the duodenojejunal juncture.

[1] Annals of Surg., Jan., 1908.

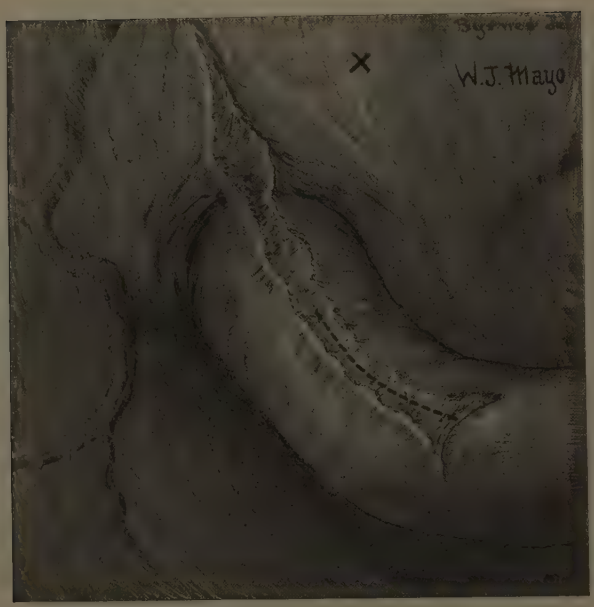

FIG. 242.—THE PERITONEAL FOLD SEPARATED. (Mayo.)
Dotted line shows proper situation for a no-loop gastro-enterostomy. X marks the point in the transverse mesocolon where the stomach is to be brought out.

This, he believes, to be the best method of performing posterior gastro-enterostomy without a loop.

THE GASTRIC LYMPHATIC SYSTEM AND ITS BEARING ON GASTRECTOMY FOR CARCINOMA.

Anatomic Considerations.—The work of J. K. Jamieson and J. F. Dobson on the lymphatic connections of the stomach has added considerably to our knowledge of the subject. It is based on the examination of thirty stomachs injected by the method devised by Gerota.

An exact knowledge of the lymphatic connections of the stomach is of great practical importance, and during recent years a good deal of attention has been given to the subject. Practically, our knowledge of it is recent, and dates from the appearance of the memorable work of Cunéo. His researches into the anatomy of the lymphatics of the stomach and their importance, in view of the spread of malignant disease, have excited general attention, and have resulted in considerable modifications in operative technic. The involvement of the lymphatic glands of the stomach in conditions other than malignant is a subject of which little is known. It is recognized that the glands may be enlarged and indurated in cases of ulcer of the stomach, simulating malignant disease to such an extent that errors in diagnosis and treatment have not infrequently resulted. Whether the affection of the glands in such cases ever proceeds beyond a chronic inflammation it is difficult to say. It is possible that suppuration may occur in these glands in cases of peptic ulcer; this may be an explanation of those occasional cases of

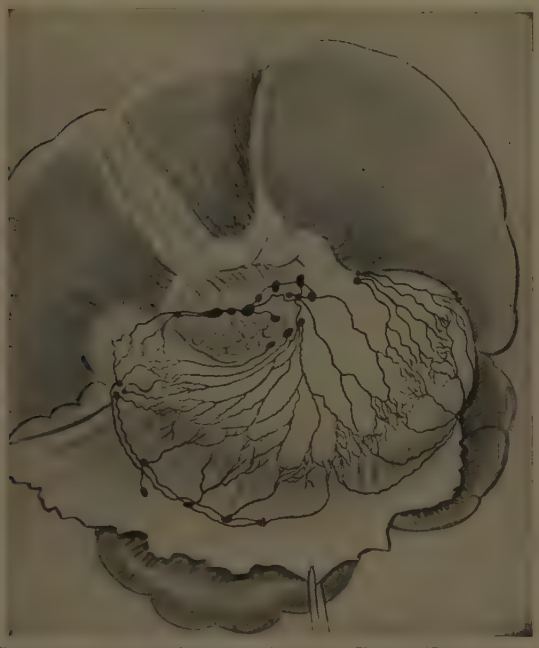

FIG. 243.—LYMPHATICS OF THE STOMACH: ANTERIOR VIEW. (Jamieson and Dobson.)

FIG. 244.—LYMPHATICS OF THE STOMACH: THE ORGAN HAS BEEN LIFTED UP. (Jamieson and Dobson.)

subdiaphragmatic abscess which arise during the course of this disease, and which are usually attributed to a subacute or chronic perforation

of the stomach. This, however, is mere speculation, though the point may be worthy of investigation. Letulle considers that glands in the walls of the stomach may not infrequently become diseased, and may give rise to such conditions as "tuberculous abscess opening into the

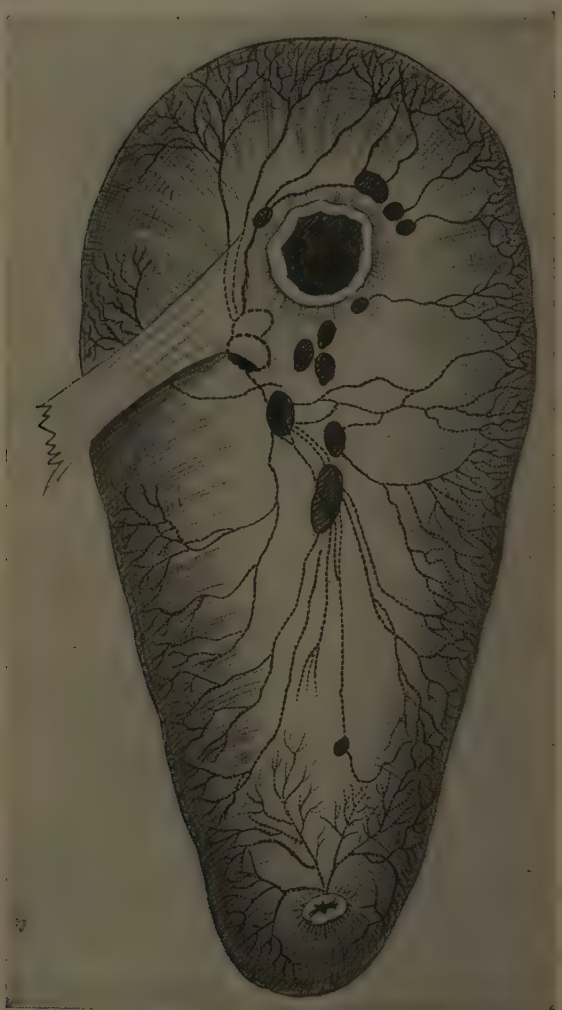

FIG. 245.—LYMPHATICS OF THE STOMACH SEEN FROM ABOVE. DRAWN ON A LARGER SCALE. (Jamieson and Dobson.)

stomach," "acute interstitial abscess of the stomach wall," and "fistula and perforation in gastric cancer."

Whatever be the changes in the lymphatic apparatus which occur in the more simple diseases of the stomach, there is no doubt of the importance of their affection in malignant disease. The brilliant essay by Cunéo contains a most exhaustive examination of this subject.

He considers that the lymphatic vessels in the wall of the stomach play a most important part in facilitating the growth of the primary tumor. This is especially so with regard to the well-known tendency of gastric cancer to extend along the lesser curvature from the pylorus. The equally well-known fact of the comparative integrity of the duodenum is not so easily explained by the disposition of the lymphatics. As there is a communication between both the subserous and the submucous plexuses of the stomach and duodenum, it is obvious that the duodenum may possibly become invaded from the pylorus by the extension of cancer along either plexus.

The invasion of the lymphatic glands in gastric carcinoma is of the greatest practical interest. This invasion takes place by a process of embolism; cells, or small masses of cells, become detached from the primary growth and are carried along the lymphatic vessels to the corresponding glands. There seems to be no doubt that the emboli are always arrested at the first gland which they can reach (the primary gland), and that they do not pass on to a secondary gland until the process of growth in the primary gland has advanced to a marked extent. Cunéo speaks of the affection of the primary glands as "immediate adenopathies," and of the secondary glands as "distant adenopathies." Histologic examination of the glands of the stomach in cases of malignant diseases has been made by numerous observers, notably Carle and Fantino, Cunéo, and Borrmann.

Cunéo found that the glands of the lesser curvature were involved in 87 per.cent. of cases examined, the glands of the greater curvature in 66 per cent.; he has only seen the retropyloric glands (the group termed subpyloric) invaded in 2 cases. He believes that a marked preference is shown toward invasion of the glands of the lesser curvature. Lengemann found that the coronary glands were diseased in 50 per cent. of the cases, the glands along the greater curvature in 37 per cent., and the retropyloric glands (the subpyloric group) in 60 per cent. A marked divergence of opinion is here shown as to the extent of the invasion of the subpyloric group. Anatomic observation would seem to demonstrate the fact that Lengemann's statistics are most likely to be correct.

Cunéo regards it as essential, in every radical gastrectomy, completely to remove the diseased glands, and that this removal must include all the glands receiving vessels directly from the pyloric portion of the stomach. He believes that this can be effected by extirpating the glands of the lower coronary chain and the right gastro-epiploic chain (including in these what Jamieson and Dobson have termed the subpyloric glands). With this idea, he designed the operation which was described for the first time in his monograph. This operation, first performed by Hartmann in France, and subsequently by other surgeons, notably Moynihan in England and Mayo in America, consists in the excision of a large part of the stomach, including the whole of the lesser curvature, with the glands there situated, about half the greater curvature, with that part of the omentum containing the right gastro-epiploic glands, and about an inch of the duodenum. The operation

was also designed to include the subpyloric group of glands (retropyloric of Cunéo); whether this step has been effected in the majority of these operations is questionable. Some divergence of practice has prevailed as to the amount of the greater curvature which should be removed, but the method of Cunéo and Hartmann, of placing the line of section at a point vertically below the esophagus, has been generally adopted. An essential step in the operation is the preliminary ligature of the various arteries, coronary, pyloric, gastroduodenal, and left gastro-epiploic. The coronary artery is ligatured by Cunéo and Hartmann, as it lies in the falx coronaria, just before its bifurcation. Moynihan, on the other hand, ties the descending branch of the coronary artery at the upper part of the lesser curvature. By this operation Cunéo believes that the first glandular relay of the pyloric portion of the stomach is removed, and that, if the operation is performed before infection has passed the first relay, it is a truly radical measure, and may be expected to be definitely curative.

It is an extraordinary thing that both Cunéo and subsequent writers have entirely ignored the possibility of infection spreading along the lymphatics running with the pyloric artery. As Jamieson and Dobson have shown, these vessels, which are fairly numerous, and which drain a well-marked area of the pylorus, run directly to the right suprapancreatic glands lying along the trunk of the hepatic artery. Occasionally one of these vessels is interrupted by a small suprapyloric gland. Further, as is shown in several of their specimens, one of these vessels frequently runs behind the duodenum to a gland of the biliary chain. Here there is an obvious route by which cancerous emboli from a growth of the pylorus may reach, without any interruption, both the glands at the upper border of the pancreas and those of the biliary chain. Unfortunately no routine histologic examination of the state of these glands in gastric carcinoma has been made.

Passing now to the coronary chain, Cunéo appears to think that by removing these glands lying along the lesser curvature (the lower coronary group) all the glands of this chain receiving vessels from the pyloric portion of the stomach will be secured. He states that this group (lower coronary) forms the first relay, while the glands of the falx (upper coronary) form a second relay, the neoplastic elements being arrested for a time in the glands of the first relay. Jamieson and Dobson have shown, however, that vessels may run past these glands (lower coronary) to the glands of the upper coronary group, lying in the deeper part of the falx coronaria, close to the upper border of the pancreas.

The absolute necessity of removing the subpyloric group (retropyloric of Cunéo), if the operation has any claim to be considered a radical one, is shown by the large number of vessels running from the pylorus directly to this group; this is also borne out by the researches of Lengemann, who found these glands diseased in 60 per cent. of cases examined. As previously stated, it appears unlikely that these glands are often secured; Cunéo himself says that their removal is difficult

and that they are fortunately frequently absent. The difficulty of completely removing them when they are diseased can be imagined, but the view that they are frequently absent cannot be endorsed. Consideration of these points will show, therefore, that the ideal of Cunéo—namely, the removal with the primary growth of the first glandular relay—cannot be realized. This relay includes the lower coronary glands, the upper coronary glands (extending almost to the upper border of the pancreas), the right gastro-epiploic, the subpyloric, the right suprapancreatic, and the biliary glands, many of which are beyond the effective reach of the surgeon. Except as a mere matter of chance, no operation for gastric carcinoma can be a radical one when once malignant emboli have commenced to reach the lymphatic glands. The only reason for removing as many of the diseased glands as possible is the hope that, once the primary growth and the majority of affected glands have been removed, the remaining glands may be able to deal with and perhaps destroy the malignant elements they contain; of this process, however, we know little or nothing.

If surgery is ever to offer to the subjects of gastric carcinoma the hope of cure by a radical operation, it can only do so when a very early diagnosis has been made, when the growth is yet small, and when the embolic process of lymphatic invasion has not yet commenced. The question of the performance of a partial gastrectomy merely as a palliative measure instead of a gastro-enterostomy is not affected by these considerations.

The study of the spread of malignant disease of the stomach to the other groups of abdominal lymph-glands is much facilitated by an accurate knowledge of the course of the lymphatic vessels. The group of glands usually found affected in the late stages of the disease are the glands at the hilum of the liver, the glands around the celiac axis, the superior mesenteric glands, the biliary glands, the mesocolic glands, and the lumbar glands. There are no direct vessels connecting the stomach or any of the gland groups receiving direct vessels from the stomach with the glands at the hilum of the liver. These glands receive vessels from the liver, and transmit them to the right suprapancreatic and biliary groups. In advanced carcinoma of the stomach they must become diseased, either by retrograde infection along their efferent vessels or secondarily to a growth in the liver. The paths by which the middle suprapancreatic glands are affected can easily be followed: from the coronary groups, the subpyloric group, or the splenic group. They transmit efferent vessels not only to the receptaculum chyli, but also to the lumbar glands around the aorta and vena cava. It is obvious that these glands may readily become diseased by the direct transmission of cancerous emboli from the middle suprapancreatic glands. The superior mesenteric glands receive vessels from the subpyloric group. This group is frequently diseased, and infection will spread readily along its efferent vessels. It is not necessary to assume, as is done by Stevens, that the glands lying below the level of the celiac glands become diseased by means of a process of retrograde infection,

or secondarily to obstruction of the thoracic duct, or to the development of metastases in the liver. There are direct paths, as have been shown. The affection of the mesocolic glands is not so readily explained. They may become diseased by retrograde infection from the superior mesenteric glands to which their efferent vessels run; a more likely explanation is that the primary disease has spread from the stomach into the gastrocolic omentum, possibly to the colon or into the mesocolon, thus invading the lymphatic area draining into the mesocolic glands.

The biliary group of glands receive direct vessels from the upper part of the pylorus; by this path they may become affected. There are many interesting problems connected with the dissemination of malignant disease of the stomach by means of the lymphatic system, but the researches being carried out by Jamieson and Dobson do not permit at present any definite statements as to the connection between the lymphatics of the stomach and the glands of the diaphragmatic groups, of the internal mammary chain, and of the mediastinal groups. They hope that further investigations by means of Gerota's method will clear up many obscure points.

The proper appreciation of the arrangement of the lymphatic glands and vessels of the stomach depend largely on a knowledge of the disposition of the blood-vessels of the organ. The areas drained by the lymph-vessels are found to correspond quite closely with the areas supplied by the arteries, and the course of the vessels beyond the stomach is not in any great degree dissimilar to the course of the arteries and veins; sometimes, however, it is an artery and sometimes a vein which pilots the lymph-vessel. This observation holds good for the vessels up to their termination in the glands; the efferents of the glands pursue paths independent of blood-vessels, as their destination is the receptaculum chyli.

The lymphatic system of the stomach is even more complicated than either its arterial or venous systems, and the numerous gland-groups present great difficulties to the describer, not on account of a want of definite position, but because it is not an easy matter to find a suitable name for each gland-group. As in other organs, the glands which receive the lymph-vessels from the stomach are associated with the arteries which supply the organ. A close examination of the specimens has shown that there is an unexpected connection between the lymph-vessels of the stomach and glands which seem, from their position, to be totally unconnected with it. This compels a description not only of those glands which are usually described as concerned with the stomach, but also of the mesenteric and lumbar glands and of the glands surrounding the ductus choledochus communis. With the exception of the glands in contact with the stomach, all these groups are termini for the lymph-vessels of other organs, such as the liver, spleen, pancreas, and duodenum.

The gland groups may be named: (1) Lower coronary; (2) upper coronary; (3) right paracardial; (4) left paracardial; (5) posterior paracardial; (6) splenic; (7) right gastro-epiploic; (8) subpyloric; (9) supra-

pyloric; and (10) suprapancreatic. The lower coronary, paracardial, suprapyloric, right gastro-epiploic, and splenic glands are primary glands, receiving vessels directly from the wall of the stomach. The upper coronary, subpyloric, and right and left suprapancreatic groups are secondary, inasmuch as they receive efferent vessels from the primary glands, but are also primary, as they also receive vessels directly from the stomach. The middle suprapancreatic, mesenteric, and lumbar groups are entirely secondary, receiving only efferents of more intimate gland-groups.

The topographic anatomy of the various gland-groups is described as follows by Jamieson and Dobson:

The Glands Associated with the Coronary Artery.—Along the descending branches of the coronary artery, between the layers of the gastro-hepatic omentum, close to its attachment to the lesser curvature, are found numerous glands. Although the greater number lie close to the artery, it is not uncommon to find small glands which have insinuated themselves under the peritoneum beyond the omental attachment and lie in intimate contact with the muscular wall or even imbedded in it. The glands are rarely seen to the right of a point midway between the esophageal and the pyloric orifices. They increase in number and size as the cardia is approached, often forming a distinct mass on the right side of the cardia, at the commencement of the descending coronary branch. This chain of glands is termed the lower coronary chain.

The glands which lie in the falx coronaria with the stem of the coronary artery are indicated by the name of upper coronary. They are numerous, and so disposed that members of the group are seen on both sides of the falx. The chain is directly continuous with the inferior coronary chain, and it is for convenience in dealing with the afferent vessels and to emphasize certain points in their disposition that two groups are distinguished.

The paracardial glands are outlying members of the coronary chain, disposed in a manner comparable to a chain of beads around the neck of the stomach. One or two glands (right paracardial) are constantly found in front of the right side of the cardia, and from their position and the arrangement of their efferent vessels are members of the lower coronary group. One or more, sometimes as many as seven, small glands are situated on the left side of the cardia. These are the left paracardial glands. On the back of the cardia, sometimes under the peritoneum and sometimes on the small bare area between the lesser and greater sacs, lie one or two small glands, which are called the posterior paracardial. They are not so constant in their presence as the right and left paracardial glands, but as their efferents join the upper coronary glands, and they lie only a very short distance from those glands seen on the left side of the falx, it is probable that when absent they are represented by a member of this group. This opinion is strengthened by the fact that the vessels which they intercept are, in their absence, afferents of the upper coronary glands.

If we follow the upper coronary glands backward we find that they

are continuous with the glands which lie at the upper border of the pancreas around the celiac axis. As the name celiac glands is used to define loosely the row of glands lying along the upper border of the pancreas, and as this row of glands receives vessels from distinct parts of the stomach, it has been found necessary, for exact description, to divide these glands into three groups: middle suprapancreatic, around the celiac axis; left suprapancreatic, on the stem of the splenic artery; and right suprapancreatic, on the stem of the hepatic artery. It will be more evident, when describing the afferent vessels of these glands, why this chain of glands has been divided into groups, to the continuity of which at the same time prominence is desired to be given.

The chain of glands associated with the splenic artery is more simple in its arrangement and of less practical importance than the other chains. The first glands met with are a few in the gastrosplenic omentum. They are inconstant and rarely number more than two. A gland has been met with (specimen 100) lying in the omentum close to the stomach, but they are usually situated close to or in the splenic attachment. In many cases no gland appears to exist in the omentum. It is more common to find that the splenic glands are in close contact with the pancreas on the upper aspect of the tail, while sometimes a gland may lie at the lower border of the tail. These glands are all asosciated with the terminal branches of the splenic artery. On the stem of the artery, at the upper border of the pancreas, lie a variable number of glands which have been termed the left suprapancreatic group. They are continuous to the right with the middle suprapancreatic group around the celiac axis.

The glands associated with the hepatic artery and its branches fall into several groups. Along the right gastro-epiploic artery, in the gastrocolic omentum, is found a chain of small glands, usually from four to seven in number. They are generally situated below the artery, and, being thus deprived of their mechanical support, they show a tendency to stray down between the layers of the omentum; this displacement is more often seen in adult than in fetal specimens. No glands of this chain were found to extend to the left beyond the middle of the greater curvature; to the right they do not extend quite to the pylorus. Without exception their efferents end in the next group.

The Subpyloric Group.—The only convenient name which can be applied to this group does not suggest its exact position. The group is situated to the right of the pylorus, in the angle between the first and second parts of the duodenum, in front of the head of the pancreas in close relation to the bifurcation of the gastroduodenal artery, covered in front by the peritoneum of the greater sac and having the lesser sac to its inner side. It consists of four or five glands. It is a secondary group for the prepyloric region, but primary for the pylorus and duodenum. As it is associated with the gastroduodenal artery, it is included in the hepatic artery chain, but, as will be shown later, its efferents have little or no connection with the glands on the trunk of the hepatic artery.

It is uncommon to meet with glands along the course of the pyloric artery. Sometimes a small gland is seen on the artery immediately above the duodenum, and perhaps more frequently some little distance above the pylorus. These glands are named the suprapyloric glands; when present they intercept only one or two pyloric lymphatic vessels. The right suprapancreatic glands lie along the trunk of the hepatic artery as it courses to the right at the upper border of the pancreas. They are constant, and are the largest and most easily observed of the glands above the pancreas. Their large comparative size in the fetus is doubtless explained by the fact that they receive a large part of the lymph from the liver.

In addition to the groups of glands which are closely connected with the stomach, three other groups require mention; they are the biliary, superior mesenteric, and lumbar glands. The biliary glands form a well-marked chain lying along the common bile-duct. The uppermost member of the chain is the cystic gland. In the free edge of the omentum the glands are few, but behind the meeting of the second part of the duodenum and the pancreas they are numerous and large. Around the stem of the superior mesenteric artery lie several large glands which receive the lymph from the mesenteric, ileocolic, and mesocolic glands. It will be shown that they are immediately connected by more than one path with glands which receive lymphatics of the stomach.

The vessels at the cardiac end of the stomach are directly continuous with those of the esophagus. There has been some doubt expressed as to the presence of a similar continuity of the gastric and duodenal plexuses. If an injection is made into the subserous plexus to the left of the pylorus, the injection flows toward the curvatures and the injected area is generally sharply marked off at the pyloric ring. It has been noticed that this occurs when there is much extravasation, which may compress the subserous network, but in one specimen (No. 72), where there is very little extravasation, the injected area extends for some little distance on to the duodenum. There is no doubt of the direct continuity, but the plexus over the pyloric ring itself is not well marked. In common with other observers, Jamieson and Dobson have been unable to detect any annular vessel acting as a barrier, as has been described by Most.[1] Many of the collecting vessels from the pyloric subserous network run downward over the duodenum to reach the subpyloric glands, and, as they must receive vessels from the duodenum, an indirect communication is also present. When the submucous plexus of the pyloric canal is injected the fluid runs most readily to the left, but, at the same time, it fills up the plexus of the ring and spreads into the duodenal plexus. This is evident at the time the injection is made by vessels bursting through the muscular coat and running on the surface toward the upper and lower borders of the duodenum. These vessels have been seen on both surfaces of the duodenum, but in larger numbers on the posterior surface. Since there is such a

[1] Ueber d. Lymphgefasse u. d. Regionaren Lymphdrusen d. Magens, etc., Archiv. klin. Chir., lix., 175.

well-marked continuity of gastric and duodenal submucous plexus, and since a free communication exists between the submucous and subserous plexuses, the question of direct continuity of the subserous plexuses is of little or no importance.

The collecting vessels which arise in the plexuses, from the upper part of the area to the right of the esophagus as far as the pyloric canal, ascend to the lesser curvature. Those from the pyloric end of the area have a long oblique course, the succeeding vessels, as we pass from right to left, becoming more vertical in direction. The great majority of these vessels end in the glands of the lower coronary group. It is a point upon which we cannot lay too much stress that some of these vessels slip past the lower coronary group and enter glands of the upper coronary group as it lies in the falx coronaria. This is true not only of the vessels arising from the left portion of the curvature and from the anterior and posterior surfaces, but also of vessels arising from the pyloric extremity. In small specimens this condition is easily overlooked, and in dissecting these specimens it must always be borne in mind that vessels which seem to enter a gland may be only in contact with it on their way to more distant glands. As in the case of the appendix and cecum, it is found that a vessel arising from the lower part of the area may reach the highest gland of the uppermost group which receives vessels from the area.

The vessels from the anterior wall of the stomach below the esophagus run into the right paracardial glands, but the area which in one case may send all its vessels to these glands may in others furnish efferents to the lower or upper coronary groups. The efferent vessels of these glands run to the upper coronary group.

From the upper and anterior aspects of the fundus as far out as the summit, and often well down over the body, the vessels converge to the left paracardial glands. The efferent vessels run behind the cardia and end in the upper coronary group. If a posterior paracardial gland is present it will intercept one or more of the efferents. Occasionally efferent vessels have been seen running in front of the cardia, from the left to the right paracardial glands, but this path does not seem to be at all constant. Here, again, we may see vessels from the fundus running past the left paracardial glands, to end in the upper coronary group. From the posterior surface of the fundus vessels run to the posterior paracardial gland. If this is absent, they enter the upper coronary glands. Occasionally a vessel has been seen from the summit and even from the anterior surface of the fundus, ending in the posterior paracardial gland. The efferents of this gland run to the upper coronary group. The upper coronary glands receive, therefore, not only the efferents of the lower coronary glands and of all the paracardial glands, but, in addition, vessels direct from any part of the area draining into these glands, no matter how distant.

The vessels which enter the gastrosplenic omentum are derived from both surfaces of the stomach—from the summit of the fundus to a point on the greater curvature vertically below the esophagus. During

the injection, as they lie in the loose omentum, they are apt to become kinked by the handling of the specimen, and the injection often fails to reach the glands. The lower vessels, which accompany the left gastro-epiploic artery and the lower vasa brevia, run to the hilum of the spleen and end in the splenic glands above and occasionally below the tail of the pancreas. One or two vessels may be intercepted by small glands in the omentum, but this is uncommon. The upper vessels from the left side of the fundus sweep downward over the summit of the lesser bag in the upper part of the omentum and reach the left suprapancreatic glands. The efferent vessels of the splenic glands pass inward to the left suprapancreatic glands along the upper border of the pancreas. If any glands lie at the lower border of the tail of the organ their efferents run obliquely upward over the body. The efferents of the left suprapancreatic glands run to the middle suprapancreatic group.

The vessels from the right portion of the greater curvature as far as the pyloric canal run downward into the great omentum; turning to the right, they end in the right gastro-epiploic glands. These glands send their efferent vessels, without exception, to the subpyloric group. The vessels from the lower part of the pyloric canal pass obliquely to the right, some of them lying on the duodenum, to enter the subpyloric glands. The efferent vessels of these glands are noteworthy in their arrangement. Many curve downward in front of the head of the pancreas and end in the superior mesenteric glands. Others run inward for a short distance, and, on reaching the lower border of the neck of the pancreas, turn upward and run obliquely over the anterior surface of the body of the organ to the middle suprapancreatic glands. There are usually two such vessels, and sometimes one of them enters a right suprapancreatic gland. In two specimens only Jamieson and Dobson saw the path which is usually regarded as normal, viz., that taken by vessels which ascend behind the duodenum with the gastroduodenal artery to reach the right suprapancreatic glands.

The upper part of the pyloric canal presents a most interesting arrangement in collecting vessels. It has already been stated that vessels pass upward from this part to the coronary groups. Jamieson and Dobson find that there are two other sets of vessels. One set runs upward into the lesser omentum, possibly having one or two vessels intercepted by a suprapyloric gland; the efferents of this gland, together with the uninterrupted vessels, turn downward and end in the right suprapancreatic glands on the stem of the hepatic artery. The other set, consisting usually of only one vessel, separates itself from the other vessel, turns to the right behind the duodenum, to a gland behind the head of the pancreas on the lower end of the common bile-duct, a gland of the biliary chain. Thus lymph may be carried from the upper border of the pyloric canal to the lower and upper coronary, suprapyloric, right suprapancreatic, and biliary groups of glands.

The suprapancreatic glands send efferents to the receptaculum chyli. They communicate freely behind the pancreas with the superior mesenteric glands. Jamieson and Dobson state that their specimens do not

inform them with certainty whether the vessels behind the pancreas in all cases run from the suprapancreatic to the superior mesenteric glands. In some cases they have seen evidences of spread in the reverse direction. When the suprapancreatic glands are fully injected, they have found a vessel descending from the middle group behind the pancreas and duodenum to glands of the lumbar group. In 3 cases the gland injected lay just below the left renal vessels; in another it was situated between the aorta and vena cava, at a still lower level.

The description of the lymphatic system of the stomach is based solely on the information derived from their own specimens. Jamieson and Dobson do not review the work of all the observers who have furnished the statements in text-books, but in recent years Cunéo and Delamere, Most, and Polya and von Navratil[1] have published observations which they compare with theirs. The coronary glands do not admit any difference of opinion as to their disposition and constant presence, but, in the case of the outlying members which are disposed around the cardia, Jamieson and Dobson differ from Cunéo and Delamare, who say that the precardiac and retrocardiac glands are constant, and that the gland on the left side of the cardia is usually absent. They were only successful in injecting these glands on three occasions, however. Jamieson and Dobson find that the right paracardial is constant, the left paracardial only occasionally absent, and the posterior paracardial more frequently absent, as it is often included in the upper coronary group. From their drawings, it appears that their precardiac group may be our left paracardial. Polya and von Navratil speak of these glands as right and left juxtacardiac and retrocardiac; they appear to include in the right juxtacardiac group some of the glands of the lower coronary chain, but their left group is the same and they have often seen it. No observer, so far as they know, has detected vessels ascending from the pyloric canal to reach the upper coronary glands in the falx coronary, near the upper border of the pancreas. Further reference is made to the practical importance of this fact.

Cunéo and Delamare have never seen glands in the gastrosplenic omentum, and Polya and von Navratil also note their absence. Certain of Jamieson and Dobson's specimens show small glands in this omentum close to the spleen, and in one case a gland is to be seen close to the stomach; their occasional presence, therefore, cannot be denied. The disposition of glands at the hilum of the spleen is so variable that they cannot lay any stress on the condition sometimes seen of a gland lying below the tail of the pancreas, the efferents of which course obliquely over the body of the organ to the suprapancreatic glands. Polya and von Navratil demonstrate the primary character of the left suprapancreatic glands, an observation which Jamieson and Dobson are able to confirm. This fact has not been noted by Cunéo and Delamare.

The nomenclature of the glands associated with the hepatic artery has given rise to much confusion. Cunéo and Delamare apply the

[1] Untersuch. u. d. Lymphabahn. d. Wurmfortsatz. u. d. Magens, Deut. Zeit. Chir., 1903, lxix., p. 421.

term subpyloric to those glands which lie in the great omentum below the pyloric portion of the stomach. Polya and von Navratil include in this term the glands which lie in the angle below the first part of the duodenum. As there is a distinct interval between these two groups of glands, Jamieson and Dobson have named the first group the right gastro-epiploic and the second the subpyloric. When we read the description of the retropyloric group, given by Cunéo and Delamare, we are at a loss to understand their meaning. Jamieson and Dobson do not find glands as Cunéo and Delamare describe them on the gastroduodenal artery as it descends behind the duodenum; their retropyloric group appears to them to be the group they have termed the subpyloric. As Polya and von Navratil use the term retropyloric to indicate the glands at the upper border of the pancreas on the trunk of the hepatic artery, they have avoided the word. In both papers the efferent vessels of the subpyloric glands are described as ascending with the gastroduodenal artery to the glands on the hepatic artery (right suprapancreatic). Jamieson and Dobson have seen these vessels only on two occasions.

Cunéo and Delamare mention the mesenteric path from the subpyloric glands as having been observed in one case; Polya and von Navratil have observed it frequently. Jamieson and Dobson believe that it is constant, as it may be observed in any well-injected specimen. The vessels which pass obliquely over the body of the pancreas from the subpyloric glands are neither figured nor described by Cunéo and Delamare; Polya and von Navratil have demonstrated these vessels. Jamieson and Dobson have seen them frequently and believe them to be constant. They have been unable to find any evidence that the vessel which arises from the upper border of the pylorus, and descends behind the duodenum to a gland of the biliary chain, has ever been described. The chain of glands is well shown by Cunéo; no mention is made of any vessels reaching it from the stomach. In one of the early specimens they detected the presence of a vessel descending from the suprapancreatic glands to a gland of the lumbar group. Having their attention directed to it in this way, and finding that Polya and von Navratil had seen it in one of their specimens, Jamieson and Dobson looked for and found it in cases where the suprapancreatic glands are fully injected. Cunéo and Delamare had not recognized this path.

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CHAPTER CXXV.

INTESTINAL SURGERY.[1]

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Within the last few years intestinal surgery has received much study from the physiologic side, and while nothing definite has been determined, the studies of Maury, Matthews, Blake, and others are very suggestive. These men and others, by a series of experiments, have determined that the duodenum contains a substance, whether from intestinal secretion or from the adjacent glands is undetermined, which is necessary to the life of the individual. Moreover, this secretion, if held in the duodenum and absorbed or thrown back into the stomach, exerts a most serious effect upon the individual. This experimental observation explains the clinically well-known fact that the contents of the duodenum when regurgitated into the stomach in ileus are most toxic. This clinical observation has led to the common custom of washing out the stomach after any abdominal operation upon the slightest suggestion of intestinal regurgitation, a habit which has done much to reduce the mortality in gastro-intestinal operations and is altogether one of the most important advances in later years in gastro-intestinal surgery. The questions of antiperistalsis made most vital by the popularization of proctoclysis by Murphy have been studied by Eggers and others, with the result that now it is apparently settled that the intestines can have a normal antiperistalsis. The value of this from a medicinal and nutritional standpoint can be seen easily. That this is not sufficient, however, to prevent stagnation in distal blind pouches is clearly demonstrated by the clinical observation and experimental studies of Blake, who has reported a case in which a resection of a portion of the sigmoid was performed and the distal end anastomosed into the center of the transverse colon. The patient later developed a perforation of the blind distal pouch, and upon examination the pouch was found to be a dilated sac filled with feces. Experiments on dogs corroborated the deduction that it is not good surgery to leave such terminal blind pouches.

The operations of Lane and others of **total removal of the colon** have demonstrated that such complete removal is possible and that it may not be followed by serious nutritional disturbances if it is diseased. Acting as it does, however, as a reservoir from which the fluids

[1] Supplementary to Chapter LXII., Vol. IV., p. 629.

are absorbed during its churning process, its removal unless diseased would probably be followed by some unwelcome consequences.

Some interesting studies upon the **sensibility of the alimentary canal** have been made by Dr. Arthur F. Hertz in a most valuable monograph upon this subject, in which he concludes as follows:

(1) The mucous membrane of the alimentary canal from the upper end of the esophagus to the junction of the rectum with the anal canal is insensitive to tactile stimulation.

(2) The mucous membrane of the esophagus and the anal canal is sensitive to thermal stimulation, but that of the stomach and intestines is insensitive.

(3) The mucous membrane of the esophagus and stomach is insensitive to stimulation by dilute hydrochloric acid and dilute organic acids, and the rectum but not the anal canal is insensitive to stimulation by glycerin. Contact of alcohol with the mucous membrane in all parts of the alimentary canal gives rise to a sensation of heat.

(4) The surface of gastric and intestinal ulcers is no more sensitive to tactile, thermal, and chemical stimulation than the intact mucous membrane.

(5) The sensation of fulness in the alimentary canal is due to a slow increase in the tension exerted on the fibers of its muscular coat; the adequate tension is constant for each segment, but the volume of contents necessary to produce this tension varies with the tone of the muscle-fibers.

(6) The sense of fulness in the rectum has a special character, by virtue of which it produces the call to defecation.

(7) Hunger consists in a general sensation of malaise and weakness in the body as a whole and a local sensation of emptiness in the abdomen. The latter is due to the periodical motor activity of the stomach and intestines during the fasting, in which a condition of muscular hypertonus and nervous hyperexcitability exists.

(8) The only immediate cause of true visceral pain is tension; this is exerted on the muscular coat of hollow organs and on the fibrous capsule of solid organs. The sensation of pain in the alimentary canal is due to a more rapid or greater increase in tension on the fibers of its muscular coat than that which constitutes the adequate stimulus for the sensation of fulness.

(9) Pain in diseases of the alimentary canal is most frequently true visceral pain; it is sometimes due to spread of the disease to surrounding sensitive structures or to tension exerted on the peritoneal connections; it may also be situated in the skin, muscles, and connective tissues, to which it is referred from the segment of the central nervous system, which received the afferent nerves from the affected organ.

(10) Tenderness in diseases of the alimentary canal is most frequently due to hyperalgesia of the skin, voluntary muscles, and connective tissues supplied by the segment of the central nervous system which receives the afferent nerves from the affected organ. It may also be due to the increase in tension within the organ produced by the

external pressure giving rise to the adequate stimulus of visceral pain; this is rare in the stomach, but comparatively common in spasmodic conditions of the colon and in appendicitis. Lastly, it may be due to the spread of the disease to the parietal peritoneum.

(11) Visceral sensibility is exaggerated by training in hypochondriasis, and visceral and referred sensations are exaggerated by the irritable condition of the central nervous system in neurasthenia and anemia.

The well-known anatomic studies of Monks upon the blood-supply of the gut, with the clinical deductions from them by which one can locate various loops of bowel, have found a counterpart in the valuable

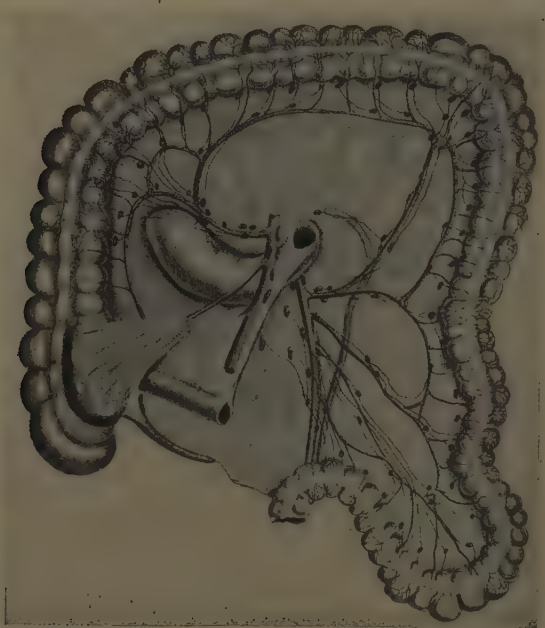

FIG. 246.—THE LYMPHATICS OF THE COLON. (Proc. Roy. Soc. of Medicine.) (Jamieson and Dobson.)

researches of Jamieson and Dobson into the **distribution of the lymphatic vessels and glands.** By these the surgeon may know what portion of the gut and the adjacent mesentery it will be necessary to remove in a malignant growth of any part of the large intestine. The original article should be read for a complete review of their work. It may be abstracted as follows:

The Lymphatics of the Large Intestine.—The lymphatic glands of the large intestine (Fig. 246) are scattered along the course of the blood-vessels and may be described in chains corresponding to these vessels, viz.: the ileocolic chain, the middle colic chain, the left colic chain, and the inferior mesenteric chain. In each chain at certain points the glands tend to form groups which, owing to the presence of scattered glands between them, are not sharply defined from each

other; it is convenient for purposes of reference to name them epicolic, paracolic, intermediate, and main groups.

The epicolic glands lie on the intestinal wall, often in the bases of the appendices epiploicæ, and are most numerous on the sigmoid flexure. They are small and unimportant and will not be mentioned in the description of the various chains.

The paracolic glands lie along the gut on the vascular arcades and the short straight terminal vessels proceeding from the arcades.

The intermediate glands are situated about midway between the arcades and the origins of the colic and sigmoid vessels.

The main group glands surround the stems of the vessels near their origin.

FIG. 247.—LYMPHATICS OF THE CECUM AND APPENDIX. ANTERIOR VIEW. (Lancet, April 27, 1907.) (Jamieson and Dobson.)

Tumors of the Ileocolic Region.—The ileocolic chain (Fig. 247) drains the lower end of the ileum, the cecum and appendix, and the greater part of the ascending colon.

In cases for radical treatment the operation necessitated by the arrangement of the lymphatics is: After exposing the field of operation the lower border of the third part of the duodenum is defined. The peritoneum over this is divided and the ileocolic vessels are found. The fatty tissue surrounding the vessels which will contain the uppermost gland of the ileocolic chain is stripped downward with gauze, care being taken not to wound the duodenum. The artery and vein are

ligated and divided close to the superior mesenteric artery. The entire diseased intestine and subjacent gland-bearing area should then be removed, including the terminal 6 inches of the ileum. The accompanying schematic drawings from Jamieson and Dobson represent this area.

The middle colic chain drains the area of distribution of the middle colic artery, the upper part of the ascending colon, the hepatic flexure, and about two-thirds of the transverse colon.

Operations for Growths in the Neighborhood of the Hepatic Flexure (Fig. 248).—Growths in this situation are not uncommon, but are rarely removable, as they quickly become adherent and fixed to neighboring structures—pancreas, duodenum, etc. To remove the "lymphatic area" it is necessary to tie the middle colic artery at its origin from the superior mesenteric and to remove the mesocolon from

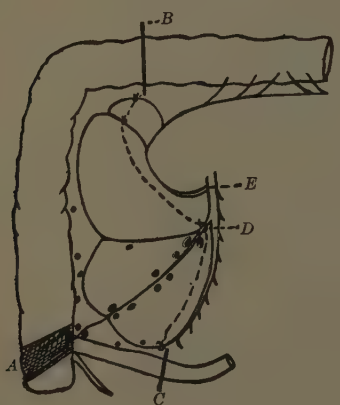

FIG. 248.—EXCISION OF GROWTH IN THE CECUM. (Jamieson and Dobson.)

A, Growth; *B*, line of section of colon; *C*, line of section of ileum; *D*, point of ligature of ileocolic artery; *E*, middle colic artery.

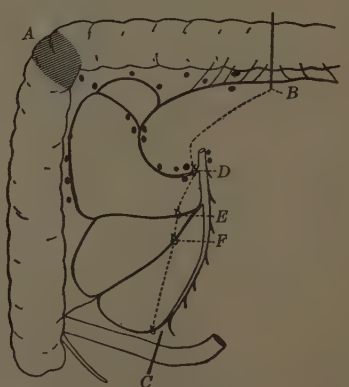

FIG. 249.—EXCISION OF GROWTH AT THE HEPATIC FLEXURE. (Jamieson and Dobson.)

A, Growth; *B*, line of section of transverse colon; *C*, line of section of ileum; *D*, point of ligature of middle colic artery; *E*, point of ligature of right colic artery; *F*, point of ligature of ileocolic artery.

this point up to the bowel. By this step the whole of the middle colic chain of glands is secured. Ligature of the artery devitalizes so much of the ascending colon—particularly in those cases where the right colic artery has origin from the middle colic—that it is necessary to remove the whole of the ascending colon, with the cecum and terminal 6 inches of the ileum, the growth at the hepatic flexure, and about half the transverse colon, completing the operation by a lateral anastomosis between the ileum and the transverse colon.

The Left Colic Chain.—The paracolic glands lie in the usual situation. The intermediate group is scattered, but the majority of the glands lie on the artery just above the point where it is crossed by the inferior mesenteric vein, in front of the inner border of the kidney.

Operations for Growths in the Middle Portion of the Transverse Colon.—We have noted above that the lymphatics of this

segment are all intercepted by the paracolic glands. The removal of a length of bowel (3 to 4 inches) on either side of the growth with the corresponding portion of the mesocolon containing these glands will suffice. It should be possible in all cases to preserve so much of the transverse colon as will permit an end-to-end anastomosis.

Operations for Growths in the Region of the Splenic Flexure (Fig. 250).—The left colic artery is defined as it leaves the inferior mesenteric vein, and is tied at this point with the accompanying vein. All the bowel supplied by these arteries is then excised. It will ordinarily extend from the junction of the middle and left thirds of the transverse colon down to the middle of the descending colon.

Operations for Growths in the Descending Colon (Fig. 251).—The "lymphatic area" corresponding to this part of the colon comprises the epicolic and paracolic glands and the intermediate glands on

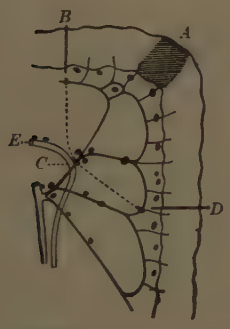

FIG. 250.—EXCISION OF GROWTH IN THE SPLENIC FLEXURE. (Jamieson and Dobson.)

A, Growth; *B*, line of section of transverse colon; *C*, point of ligature of left colic artery; *D*, line of section of descending colon; *E*, inferior mesenteric vein.

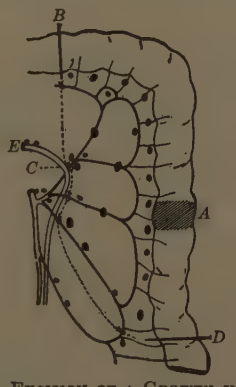

FIG. 251.—EXCISION OF A GROWTH IN THE DESCENDING COLON. (Jamieson and Dobson.)

A, Growth; *B*, line of section of transverse colon; *C*, point of ligature of left colic artery; *D*, line of section of sigmoid flexure; *E*, inferior mesenteric vein.

the branches of the left colic artery, including those on the uppermost sigmoid artery. Some vessels also run to the splenic glands, as in the case of the splenic flexure. It will then be necessary to tie the left colic artery at the point where it leaves the inferior mesenteric vein, and also the uppermost sigmoid artery close to its origin. A reference to the figure will show that beyond this step the operation is much the same as that for the splenic flexure, except that below the gut will be divided in the upper part of the sigmoid flexure.

The Inferior Mesenteric Chain.—This chain of glands drains the sigmoid flexure and rectum.

Operations for Growths in the Lower Part of the Sigmoid Flexure and the First Part of the Rectum (Fig. 252).—The glands requiring removal are those lying around the inferior mesenteric artery and its continuation, the superior hemorrhoidal artery, from the point of origin of the left colic artery downward; this includes all the primary

lymphatic glands. It is not necessary to remove the glands around the stem of the inferior mesenteric artery above the point of origin of the left colic artery. The operation consists in exposing the inferior mesenteric artery and ligating it and the vein just below the point of origin of the left colic artery. The mesosigmoid is then divided in an

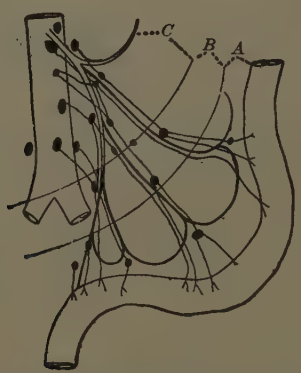

FIG. 252.—SHOWING HOW THE LOWEST AND MIDDLE GLANDS OF THE INFERIOR MESENTERIC CHAIN ARE HOMOLOGOUS WITH THE PARACOLIC AND INTERMEDIATE GROUPS ON THE SIGMOID ARTERIES. (Jamieson and Dobson.)

A, Paracolic group; *B*, intermediate group; *C*, main group.

FIG. 253.—EXCISION OF A GROWTH IN THE MIDDLE OF THE SIGMOID FLEXURE. (Proc. Roy. Soc. of Med.) (Jamieson and Dobson.)

A, Growth; *B*, line of section above the growth; *C*, line of section below the growth; *D*, the sigmoid arteries tied at their origin.

oblique line downward from the point of ligature of the inferior mesenteric to about the middle of the sigmoid flexure, care being taken to preserve as far as possible the secondary arches on the sigmoid arteries. The peritoneum to the inner side of the artery is then divided downward to the inner side of the mesorectum. The mass of tissue to be removed is then stripped forward from the sacral hollow and the middle sacral artery is secured. The peritoneal reflection from the bladder to the rectum is divided.

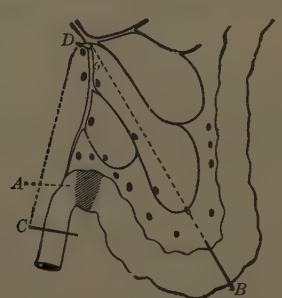

FIG. 254.—EXCISION OF A GROWTH AT THE JUNCTION OF THE SIGMOID FLEXURE AND THE RECTUM. (Jamieson and Dobson.)

A, Growth; *B*, line of section through the sigmoid flexure; *C*, line of section through the rectum; *D*, point of ligature of the inferior mesenteric artery.

Operations for Growths in the Middle and Upper Part of the Sigmoid Flexure.—The "ideal" operation in these cases is practically the same as that described above, with the difference that more of the mesosigmoid will be removed and the gut will be divided above at the junction of the descending colon and the sigmoid flexure.

Mayo has discussed with completeness the principles of **surgical technic dealing with growths in the large intestine.** In his experience the method of anastomosis after resection, whether end-

to-end or lateral, makes little difference. He favors somewhat the lateral method. In this we concur, and wish to draw attention to the fact that after the lateral anastomosis there is temporary paralysis at the site of anastomosis, so that the restoration of normal peristalsis and evacuation of the bowels is delayed for from forty-eight to seventy-two hours. This may be accompanied by considerable meteorism, leading to needless anxiety on the part of the surgeon. In end-to-end anastomosis it is rather necessary for a safe anastomosis that at least one of the fragments should be surrounded by peritoneum. Mayo reports 100 resections of the bowel, with 12 deaths.

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THE OMENTUM.

Function.—The functions of the omentum have been a subject of much speculation and considerable investigation for many years. Investigations by Neuhof and Wiener, Rubin, Norris, and others have served to dispel many of the theories and relegate it to a purely mechanical and physiologic rôle. Rubin, particularly, has shown that it has no spontaneous mobility, no demonstrable chemotaxis, no intelligent and spontaneous protective rôle. Such protection as it apparently displays is due to its inherent peritoneal properties. Later investigations have also served to refute the general belief that detached omental grafts are of material value in plastic procedures. Such grafts rapidly become necrotic.

Torsion of the Omentum.—Reports of cases with torsion of the omentum have of late years been published with such frequency that the surgeon must cease to regard them as surgical curiosities, and learn to bear the condition in mind when confronted with an atypic abdominal crisis. The classic article by Corner and Pinches has made unnecessary further exhaustive contributions, since successive reports have but verified their classifications and conclusions, with this exception, that more attention has been given of late to the intra-abdominal type occurring without the presence of a hernia of any kind. Fuller has based an excellent paper upon a case of this nature. In the collection of Lejars (66 cases) only 6 of this type were found; Fuller, a year later, was able to report 9 others besides his own. In practically every case, however, there was some adhesion present at the distal end of the omentum.

Diagnosis.—Torsion of the great omentum most commonly occurs between the ages of thirty and fifty, and is twice as frequent in males as in females, owing to the greater frequency of hernia in the former.

There was a right inguinal hernia in 33 and a left inguinal hernia in 9 of the 53 cases.

The mass may show all degrees of change consequent upon strangulation, from simple passive congestion or anemia to complete gangrene. In the subacute type adhesions may be present. In the acute type the mass may be enlarged by engorged veins and exudate, with a serous or bloody fluid surrounding it, or the twist may be so marked as to shut off the arterial supply (Blake). From two to ten complete twists may be present.

We have two types, the acute and subacute.

"*Acute Type.*—This type is characterized by all the symptoms and signs which accompany the strangulation of any abdominal structure, and, in addition, its juxtaposition to the intestinal tract may give rise to the symptoms and signs of paralytic ileus. The onset is generally sudden and is ushered in by pain which may be spasmodic, but is generally constant. Vomiting is present in about one-third and nausea in at least one-half of the cases. The bowels are not interfered with in about one-half the cases, but in a few absolute obstruction has been noted.

"(*a*) If the torsion is confined to a hernial sac we have the local tenderness, pain and swelling, with the nausea and vomiting characteristic of strangulated hernia, with this exception, that the vomiting is not so constantly present, the temperature and pulse do not rise so rapidly, although there is some elevation of both, and the evidences of intestinal obstruction are not so marked. There may be an impulse on coughing, since the strangulation is not due to the hernial ring. The mass is flat on percussion."

(*b*) The commonest form is that in which there is one mass within the hernial sac, and a second within the abdominal cavity. This condition should offer little difficulty in diagnosis, since generally the intra-abdominal mass can be defined. In the cases reported by Corner and Pinches showing this double location, 14 complained of pain in the hernia only, 17 of pain restricted to the abdomen, and 7 of pain in both localities; 11 of these referred the pain to the right iliac fossa and 1 to McBurney's point. The mass is generally hard, tender, irregular, dull to light percussion, and lies in the right iliac fossa and pelvis. In 1 case the mass was mistaken for a suppurating cyst and an attempt was made to evacuate it per vagina. It should be remembered that a twisted omentum may be reduced into the abdominal cavity, and where a history of that nature is given and an intra-abdominal tumor develops the presence of torsion of the omentum should be suspected.

(*c*) The intra-abdominal type presents the symptoms and signs of a severe intra-abdominal crisis. The tumor mass may or may not be felt.

The diagnosis of appendicitis has most commonly been made previous to operation. In one case a diagnosis of suppurating ovarian cyst was made, and in another suppurating hydatid was suspected. The diagnosis of appendicitis is excusable, since the mass almost always

occupies the right iliac fossa and the pain is referred here or to McBurney's point. The onset is sudden and with slight rise in the tem-

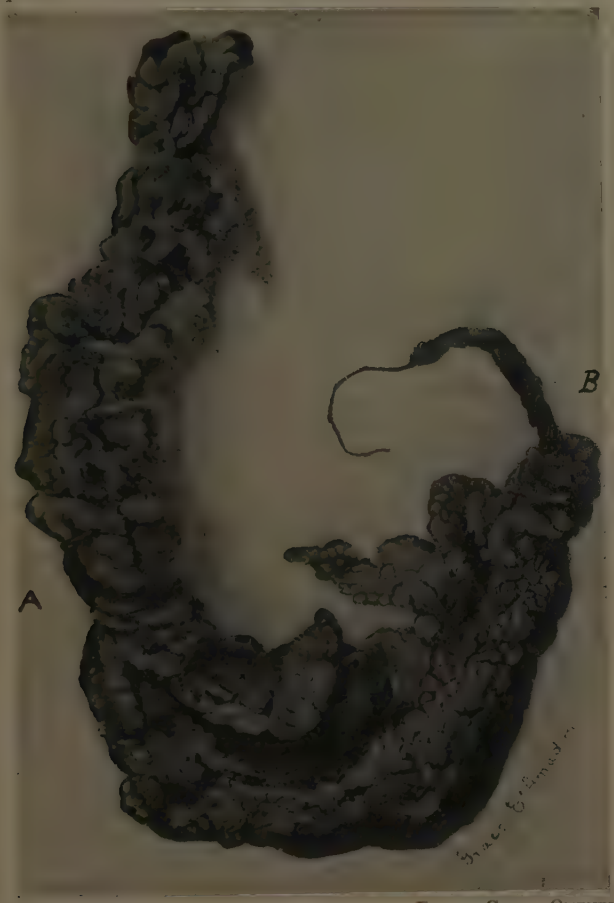

FIG. 255.—FULLER'S CASE OF TORSION OF THE ENTIRE GREAT OMENTUM.
A, Pedicle or point of constriction above the strangulated omental mass; *B*, greatly stretched adhesions twisted into a slender cord-like structure.

perature and pulse-rate. There are certain points of difference, how-
which ever, should be borne in mind.

	Appendicitis.	*Torsion.*
Age	Fifteen to thirty	Thirty to fifty.
Sex	More evenly divided	Most common in men—hernia.
Tenderness	McBurney's point	Iliac fossa.
Mass	Outlined with difficulty and late	May be outlined early.
Intestinal function	Generally obstipation	Less often obstipation.
Abdominal muscular rigidity	Frequently involuntary and restricted to right side	Voluntary, more general and not so marked.
Nausea and vomiting	Generally present	Present in about half the cases.
Leukocytosis	Present generally	Not so marked as it would be with an appendical abscess the size of the mass.

In women the differentiation from salpingitis and adnexial tumors may be made on the history and findings.

Subacute Type.—We may have a history of sudden pain and tenderness, with all the primary symptoms and signs of torsion as suggested above, which subside in from a few hours to a day or two. These attacks may be recurrent, with more or less persistent tenderness, finally culminating in the gangrenous form demanding intervention. Such attacks in the cases reported have been diagnosed recurrent appendicitis. Partial twists may persist and adhesions take place in the new position, as has been demonstrated at subsequent operation.

The prognosis is exceptionally good for such a grave condition if operation is done within reasonable time. Over 90 per cent. have recovered with operation, and doubtless as the condition is better understood the mortality will fall to less than 3 per cent.

When operating, the incision should be made along the outer border of the right rectus and an attempt made to extract the mass from the hernial sac if one is present. If this is impossible, owing to adhesions or constriction of the omentum by the ring, incision can be made over the hernial sac. The omentum is ligated in sections and the gangrenous mass excised. The abdomen can generally be closed without drainage. If a hernial sac is present it may be dealt with at the time or operated upon later, as the condition of the patient may indicate.

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DUODENAL ULCER.

Ulcer of the duodenum must be considered in connection with ulcer of the stomach, with which it is often confused. However, through the studies and contributions of the Mayos, Moynihan, Robson, and others, the condition has been shown to have a distinct clinical picture and its diagnosis and treatment have been clearly outlined. The following discussion is largely abstracted from these authors. The original contributions of W. J. Mayo and Graham, particularly, have been epoch making. The last report from their clinic gave the results in 1000 cases of gastric and duodenal ulcers. For a discussion of gastric ulcer the reader is referred to the chapter upon Diseases of the Stomach.

Etiology.—The exact cause of duodenal ulcer cannot be determined. The fact that its most frequent site is opposite the pylorus has led to the suggestion that the most active factor is the forcible ejection of the acid chyme from the stomach against this site, and the ulcer which sometimes appears upon the opposite wall has been called

by Mayo a "contact ulcer." Stiles has suggested that its frequency here may be attributed to some anatomic peculiarity of the blood-supply, and in corroboration of this Wilkie has discovered a peculiar distribution of the blood-vessels by which a single vessel supplies the first 1½ inches of the duodenum with an apparently inadequate nutrition. Of 261 patients with duodenal ulcer operated upon by Mayo, 77 per cent. were males and 23 per cent. were females, and he has suggested as a possible explanation of this fact that in the male the first or ascending portion of the duodenum seems to ascend a little higher than in the female; consequently in the latter the alkaline biliary and pancreatic secretions may rise higher and more readily neutralize the acid chyme. Be these factors as they may, it is probable that a perverted gastric function ending in hyperchlorhydria is a forerunner, and a general debility or lowered resistance is a favoring factor.

Pathology.—The ordinary type of ulcer that comes to surgical intervention is the chronic indurated ulcer, an ulcer which has persisted for a long time and is surrounded by a zone of scar tissue. Acute peptic ulcers and mucous erosions do appear, and from these hemorrhage may occur. They are seldom surgical, however. The chronic indurated ulcer may lie at any part of the duodenum, but in 95 per cent. of the cases is within ¾ inch of the pylorus, while 20 per cent. involve the margin of the stomach at the pylorus. The ulceration extends into the muscular tissue and may perforate, with attending peritonitis and death or subsequent adhesions, to various organs, which in itself may give rise to symptoms and secondary disease. Two-thirds of all gastric and duodenal ulcers are found in the duodenum. Duodenal ulcers seldom undergo carcinomatous change.

Symptoms.—Graham emphasizes four important points, and the following is taken *verbatim* from his articles:

First, the periodicity of attacks of gastric and duodenal ulcers. Second, the number of years through which these attacks and intermissions or remissions have run before surgical relief has been advised or, perhaps, accepted. Third, the characteristics of pain, its great diagnostic significance, and its place in differential diagnosis. Fourth, the ready control of all symptoms during the period of attack by measures that control pain—as food, alkalis, irrigation, and vomiting.

Periodicity.—The periodicity of attacks is so constant and striking a feature of ulcer of the duodenum that one cannot but have in mind this lesion when the patient complains of repeated attacks, each covering days, with an intermission of normal health of varying time. The onset of symptoms is often initiated without discoverable cause, appearing suddenly and continuing without interruption for days, weeks, or even months, each day a repetition of the former, each meal producing about the same effect; first, ease, later followed by the usual syndrome of pain or burning, distress, gas, sour eructations, and vomiting of sour mouthfuls of varying quantities, all these being at their worst from two to five hours after a meal. Following this period

of attack comes an intermission of days, weeks, or months, appearing often as unaccountably and as suddenly as did the distressing symptoms.

These periods of complaint with the periods of intermission, each covering days or months, are so characteristic that, excluding other details, this one feature is often sufficient to warrant a probable diagnosis. Usually the history shows that the disease has run from five to twenty years.

The pain comes, then, in definite periods of attack; it comes daily or two or three times a day during this period; comes from two to five hours after meals, and is, therefore, pre-meal as often as it is after-meal in time. It is epigastric, radiating seldom to other areas, and, except in the later stages, is relieved in part at least by food, drink, alkalis, vomiting, and irrigation. The kind of pain depends on the pathologic condition. It may be burning, gnawing, lancinating, boring, cutting (apple-core sensation), or the felling pain of perforation.

Locating an ulcer of the peptic tract from the area of pain as given by the patient is perplexing and often very uncertain. Most of the pain is epigastric, let the lesion be where it may, but the lower the lesion the oftener is the sensation of pain to the right of the median line, and some ulcers, especially the duodenal variety, give characteristic findings. The longer food gives comfort, other things being equal (as duration of time of disease, extent of trouble, obstruction, etc.), the farther down the ulcer is situated, so that in duodenal ulcer, especially in the early days of its history, food gives relief for a longer time than when the ulcer is located higher, *i. e.*, in the stomach proper. Following this period of ease the characteristic ulcer symptoms return, of gnawing, boring, even to extreme pain, with gas, sour eructation, vomiting of various amounts and intensity, dependent on obstruction and extent of lesion.

There is, however, a pain of the cardia comparable to the boring of a bared apple-core, very distressing, foreboding, and sickening, which may be present when the lesion is purely pyloric or duodenal, and is doubtless present at times when acidity is high, but is purely a functional disorder or due to dietetic error. This pain is brought about by reverse gastric peristalsis, acidity, ulcer, then spasm of the pylorus, followed by reverse peristalsis. If the sufferer belches or vomits with difficulty the annoyance amounts to real pain, and fear of cancer is prominent. These pains come in wave periods of a few moments, and relief follows suddenly and completely at each wave if gas and sour eructation be copiously raised; or the pain gradually recedes to almost quiet if belching, eructation, or vomiting is impossible. These wave pains repeat until the stomach is relieved by measures that empty it, or they yield readily to sufficient alkalis.

When pain is at its highest, so also is gas eructation and vomiting. By removing, neutralizing, or engaging the acid in the process of digestion the pain stops, gas no longer forms, vomiting and eructation cease, and the patient enters a period of calm, to return to his former distress some time later. The degree of discomfort depends on the extent of

the lesion, the kind of food taken, and the care in its mastication. Until complications (obstruction, perforation, adhesions) have advanced the pain and other symptoms seem chiefly due to increased acidity and spasm. Reverse gastric peristalsis adds to the discomfort. Later, when complications enter for consideration, the real symptoms are obscured, and the physician is often obliged to grope in the dark for an exact diagnosis unless the patient has a judicial mind and can relate accurately his earlier symptoms.

Again, the course of ulcer, like cancer, may be long latent, and be diagnosed only when some threatening symptom, like perforation, suddenly prostrates the patient. If the perforation is not complete or if only a small amount of septic material escapes, the pain may be of short duration, but intensely sharp and lancinating, simulating so closely gall-stone colic that such a diagnosis is the only logical one to make. If the perforation is free and the fluid septic or large in amount the pain is much more intense than in gall-stone colic. There is exceeding great shock, much morphin is required to control the symptoms, and early the appendical region will be the center of the pain. Later, if the patient survives, the pain will creep to the duodenum and gall-bladder area. Under such conditions one should think of perforating ulcer rather than gall-stones or appendicitis.

Perforation may be of two types: the acute and the chronic protected. The acute is followed by peritonitis. This is not of the most virulent form, however, owing to the few bacteria present; so that, if surgical intervention is secured early, the prognosis is fair. In the subacute or chronic type there is an incomplete or small perforation followed by adhesions. Here, recurring attacks of local peritonitis are the rule. Perforation was discussed extensively in Vol. IV., p. 686. It should be emphasized that duodenal pain and tenderness are found to the right of the median line, while early the aggravation of the pain comes several hours after meals.

Examination of the contents of the stomach is of considerable aid in suggesting the proper treatment, although not necesssary for the diagnosis, since the chemical analysis is often misleading. There is an excess of total acidity and free hydrochloric acid in over half of the cases, but either may be normal or below normal. If a spasm of the pylorus is present or a stricture due to old ulceration, there will be a retention of food elements after the proper time for its extrusion. The stomach is often dilated in the same class of cases. The presence of hemorrhage, either gross or microscopic, is not characteristic, although it may be present.

Mayo calls attention to the fact that if the duodenum is pulled strongly an anemic spot may appear on the duodenum near the pylorus which may be mistaken for ulcer.

Prognosis.—Operation in uncomplicated cases in the hands of experts is followed by death in less than 2 per cent. of the cases, while 98 per cent. are cured or greatly improved. In complicated cases, where adhesions and secondary changes have occurred, the prognosis

must depend upon how well these can be handled. Undoubtedly, the prognosis under operative intervention is much better in duodenal than in gastric ulcer.

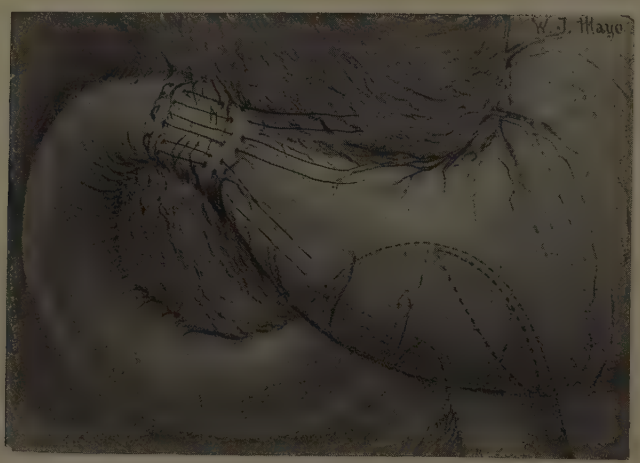

FIG. 256.—ULCER OF THE DUODENUM WITH SUTURES IN PLACE FOR THE PURPOSE OF INFOLDING. (Mayo.)
Posterior no-loop gastro-enterostomy indicated.

Treatment.—The simple chronic duodenal ulcer is probably best treated by the posterior no-loop gastrojejunostomy. If the ulcer can

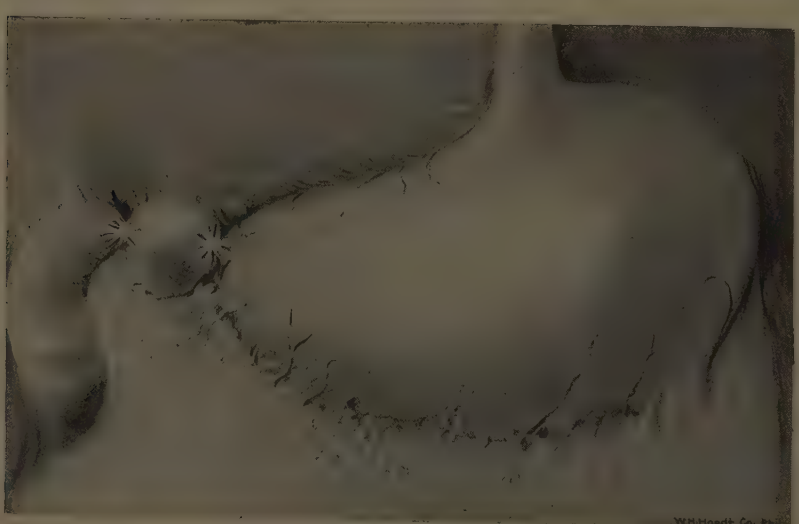

FIG. 257.—HOUR-GLASS DUODENUM. (Burke.)

be excised with safety it should be done, if near the pylorus, to prevent the possibility of cancer. Burke and Mayo have reported hour-glass constriction of the duodenum requiring resection. If the ulcer has

caused hemorrhage the vessels leading to it may be tied and the base be infolded. It should also be infolded if the base is thin, suggesting the possibility of perforation later. If perforation has occurred it is generally not necessary to do a gastro-enterostomy, since perforation seems to cure the condition. If there is any stricture, however, gastro-enterostomy should be done in addition to whipping over the ulcer.

JEJUNAL AND GASTROJEJUNAL ULCERS.

These ulcers have been the subject of further study by Paterson and Mayo. Paterson reports 2 cases and collects 61 from the literature. He has drawn particular attention to the fact that we may have gastro-jejunal ulcers situated on the gastro-enterostomy stoma. Both he and Mayo, who also reports such cases, maintain that these ulcers are the result of injury at the time of operation. One of Mayo's cases had a persistent suture, and in another a hematoma had been produced by injury at the time of operation. Paterson believes that closure of the gastrojejunostomy opening is produced by cicatrization of a gastro-jejunal ulcer, and it is more likely to occur in those patients in whom the pylorus is patent, since in those cases the hyperacidity is greater about the wound. In closing, Paterson draws the following conclusions:

The risk of jejunal ulcer following gastrojejunostomy is probably under 2 per cent.

At the present time this complication apparently occurs less frequently than formerly.

Clinically, there are two groups of cases: (1) Those in which perforation into the general peritoneal cavity ensues; (2) those in which general peritonitis is prevented by the formation of adhesions.

Pathologically, the cases may be classified as follows: (1) Ulcers of the jejunum; (2) gastrojejunal ulcers or ulcers at the site of the anastomosis.

Jejunal ulcers in some instances are of infective origin; in these cases ulceration commences within a very short interval after gastro-jejunostomy and usually the ulcers are multiple.

In a large proportion of cases the ulcer is single and is probably the result of the toxic action of hydrochloric acid which injures the cells of the mucous membrane, so that they are digested by the intestinal juice. Possibly other agents than hydrochloric acid may play a part in injuring the mucous membrane.

Any procedure or disease which diminishes the amount of bile and pancreatic juice in the jejunum favors the occurrence of jejunal and gastrojejunal ulcer. For this reason operations of the "Y-type" and entero-anastomosis are inadvisable, at any rate in cases in which free hydrochloric acid is present in the gastric contents, as after these procedures the anastomosis and a portion of the jejunum are deprived of the protective influence of the alkaline bile and pancreatic juice.

The reason that ulceration has followed the anterior operation more

frequently than the posterior operation with a loop is, probably, that in former times the anterior operation was more frequently performed.

In cases in which perforation into the general peritoneal cavity occurs, immediate laparotomy offers the only chance of saving the patient's life. Inasmuch as there is some evidence that jejunal and gastrojejunal ulcers may heal, an operation should not be performed in the chronic cases until after a thorough trial of medical treatment.

Even when surgical intervention is necessary, an attempt should first be made to diminish hyperacidity if this be present.

Our aim should be to prevent the occurrence of this complication of gastrojejunostomy. Preventive treatment consists in (1) careful and appropriate surgical technic and (2) prolonged after-treatment.

Lastly, every case of recrudescent pain of a constant character after gastrojejunostomy, especially when associated with hyperacidity or hypersecretion, should be regarded as a case of potential ulcer and treated accordingly.

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ILEOCECAL ADHESIONS—"ILEAL KINK."

("Lane's Kink," "Agglutination of the Ileum.")

This condition may be of two general types: acquired adhesions due to inflammatory disease, and angulation and constriction of the ileum due to disease *sui generis*, the exact etiology of which is still in doubt. Concerning the first type nothing need be said. The pathology and condition are well described in the chapter dealing with Appendicitis. As to the second, however, the attention of surgeons has been forcibly drawn to this condition by the writings of Lane, F. H. Martin, the Mayos, and others. It was first described by Lane, who drew attention to it in connection with his studies upon intestinal surgery. It is now recognized as a pathologic entity.

The typic cases are found in the last 6 inches of the ileum, and consist, in general, of an angulation of the intestine with the concavity downward. The central part is fixed and the two arms fall downward and become united with adhesions to themselves or to the colon. Again, we may find the ileum rolled up in its own mesentery (Figs. 259, 260).

Etiology.—Lane attributed the condition to a pull upon the end of the ileum by a prolapsed cecum, while a counter-pull was exerted by the fixation of the ileal mesentery about 3 inches from its attachment to the cecum. Martin has suggested a most plausible explanation in that

he draws attention to the fact that the condition is most likely to be found in those individuals having an enteroptosis. The fixation of the ileum by its short mesentery associated with the general prolapse seen in enteroptosis would produce the condition. Clinically, this assumption has much support. The congenital origin has further support that cases have been found in the young and in patients without any history whatever of intra-abdominal inflammation.

Symptoms.—The symptoms and signs (as described by Martin) are those incident to its supposed etiologic factor, *i. e.*, defective development of the individual with enteroptosis, and those due to a mild grade of intestinal stenosis. With exacerbation of these symptoms, incident to mild intestinal obstruction at the site, these symptoms suggest to the thoughtless the diagnosis of chronic recurrent appendicitis.

FIG. 258.—LINES OF TRACTION WITH WEIGHT IN CECUM. (Lane.)

In other words, the individuals affected are often those with slight or no forward curve in the lumbar region, forward projection of the cervical vertebræ, flat chest, perpendicular pelvis, and a preternatural projection of the lower third of the abdomen, suggesting intestinal prolapse. In general, they are poorly nourished. The symptoms complained of by the patients are as Martin gives them: extreme weakness, giving rise to disinclination to stand or walk, dyspeptic symptoms, characterized by anorexia, distress after eating from a feeling of distention rather than pain, eructation of gases, and frequent colicky pain in lower abdomen. Patients are relieved by lavage and experience the greatest comfort when on a simple, coarse, and fat diet. They are usually constipated. Backache from several sources is complained of from pulling on the mesenteries, from dragging of the kidneys, from distention of the lower bowel, and from displacements of the uterus.

"The above symptoms with others are common to all cases of general visceral prolapse, but more definite localizations are frequently revealed as the condition progresses. They are practically the same as those described by Jackson and others as due to membranous pericolitis and by Klose and Wilms as due to excessive mobility of the cecum (*vide infra*).

"The most common complication is periodic attacks of appendical colic, followed by slight inflammatory spells relieved by recumbent position and dieting, which finally develops into a constant pain of mild degree and rather extreme sensitiveness to pressure.

"As the case progresses the chronic dyspeptic symptoms increase and occasional attacks simulating mild chronic obstruction of the bowels will be revealed. These are relieved by the recumbent position, lavage, starvation diet, and enemas. The attacks become more fre-

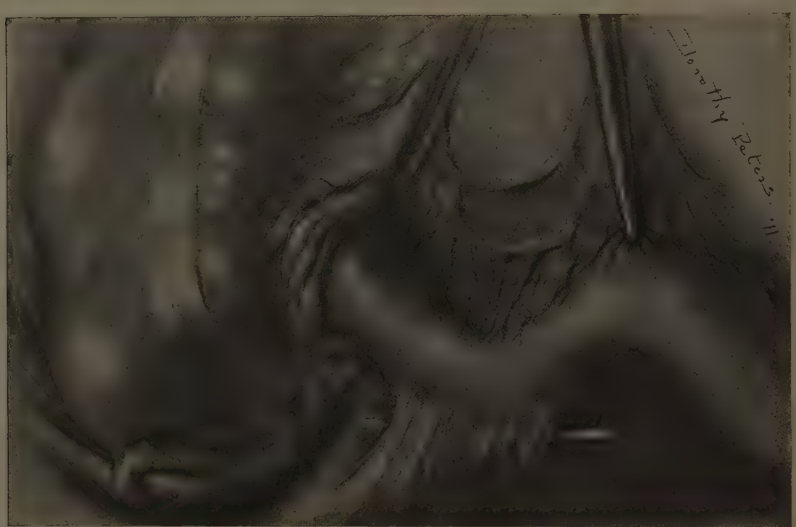

FIG. 259.—A FORM OF LANE KINK WITH ADHESIONS. (Mayo.)

quent, the pain in the region of the appendix becomes more severe and extends toward the umbilicus. During the attacks characterized by the partial obstruction symptoms the area of tenderness is increased and some tympany is revealed to the right and below the umbilicus.

"The patient in the meantime is being poorly nourished, and symptoms of general toxemia, from intestinal absorption, are apparent. This class of patients often develop extreme anemias. Occasionally severe crises develop which may be interpreted as gall-stone colic, ureteral or appendical colic, or acute obstruction of the bowel. Alternating diarrhea and constipation may be present."

Upon laparotomy one finds the appendix is obscured, but by drawing up the cecum, which is prolapsed into the pelvis, the inch-end portion of the appendix beyond its mesentery, distended and blue, is revealed; the balance of it is beneath the cecum where it has been

pulled by its high attached mesentery and blood-supply. It is frequently buried in adhesions or adherent to the under surface of the cecum, with a definite bend and usually an obstruction at this site.

The appendix is carefully removed. The loose, freely movable cecum is now drawn out and with it the first 6 inches of the ileum. At first it may be difficult to demonstrate this portion of the gut because of adhesions or because of the short mesentery. As an attempt is made to spread out the intestine the definite kink will be revealed. It is not only bent to the extent that its lumen is obstructed, but it is rolled or wrapped in its own mesentery, to one leaf of which it is firmly

FIG. 260.—LANE KINK AFTER SEPARATION OF THE BAND AND REMOVAL OF THE APPENDIX. (Mayo.)

adherent, to from one-fourth to one-half of its circumference, and to that extent still further obstructed in its lumen.

"As the kinked intestine is placed on a gauze sponge and slight tension made on it, the adhesions are revealed, and as they are carefully divided by scratching through them with the point of a knife, the bent and imprisoned intestine is relieved and its obstruction is immediately overcome.

"As the adhesions are divided and the intestine resumes its former condition, thickened portions of the mesentery are revealed, showing a hypertrophy that developed in consequence of strong pull on it. The leaf of the mesentery representing the portion adherent to or wrapped

about the gut will exhibit triangular raw surfaces, showing the extent that it imprisoned the gut.

"Careful examination of these kinks leaves practically no explanation for their formation except the one of traumatism to the comparatively fixed portion of the intestine, due to an abnormal descent of the cecum, the balance of the ileum and the overriding of superimposed viscera."

Treatment.—The simple unrolling of the gut without some method of preventing the re-forming of adhesions would seem inadequate. Therefore many suggestions have been made, such as fixation of the cecum higher up, etc. Lane in certain cases advocates extensive operations, such as ileocolostomy or ileosigmoidostomy, or excision of the colon in cases that have resisted less radical measures. Hofmeister also performs a short-circuiting operation in such cases. In an attempt to prevent the re-formation of adhesions Mayo applies vaselin to the denuded surfaces. Martin very rationally places the patient in the Trendelenburg posture after separating the kink, carefully locates the viscera, as he thinks is best, then closes the abdomen and applies a firm plaster dressing, so that the viscera are kept out of the pelvis. The patient is kept with the head low for days during the convalescence and a properly fitting straight front corset is applied before the patient is allowed to arise from bed, to be followed by a systematic course of abdominal gymnastics.

MEMBRANOUS PERICOLITIS.

("Jackson's Membrane.")

This condition, related in the symptomatology to ileocecal kinks and adhesions, was first prominently drawn to the attention of the surgical profession by Jackson, who reported cases and discussed the question in detail. He describes the condition found in one of his cases as follows:

"From a point just at the hepatic flexure to 3 inches above the caput there spreads from the parietal margin over the external lateral margin to the internal longitudinal muscle band a thin vascular veil, in which long, straight, unbranching blood-vessels course, most of which are parallel with each other and take a slightly spiral direction over the colon from the outer upper peritoneal attachment to the inner lower portion of the gut, ending just above the caput. The appendix is not implicated in any way.

"Coursing with the blood-vessels are numbers of shining narrow bands of connective tissue, which gradually broaden as they go, and end in a slight fan-shaped attachment at various points on the anterior and inner surfaces of the colon. At these points of attachment the gut is held in rigid plication.

"The entire specimen conveys to the eye the idea that an edematous fluid lies beneath this delicate membrane, and reminds one of nothing so much as an edematous arachnoid so often encountered on removing the dura mater from the brain of a dead alcoholic. The colon seems

placed in a diaphanous bag slightly too short to contain it without wrinkling. At the beginning of the hepatic flexure the drawn membrane particularly angulates the contained colon. Here and there are spots and tags of fat beneath the cobweb. On handling the specimen the colon slips about in its bag without entire freedom, as a fetus within its amniotic sac. A portion of the parietal peritoneum has been removed with the colon, and shows that the membrane and blood-vessels arise in and are continuous with the structures of the parietal peritoneum, as it sweeps over the colon. The entire structure seems to be peritoneum, loosened from its close connection to the abdominal wall and colonic surface by some serous exudate, after which the particular vascularization and connective-tissue banding has occurred as a chronic reaction to irritative influence."

Hofmeister describes veil-like adhesions, varying in density, that could be lifted up with forceps, and only after division of this delicate membrane did the true serous covering of the gut become exposed. Their consistency varies from that of a fine veil-like substance to firm strands of scar tissue. The constricting action of such bands could not be fully appreciated until one saw how the intestinal wall unfolded to its normal shape after their division.

The question has been discussed in detail by Connell, Hertzler, Crossen, and others.

Etiology.—The etiology is unknown. Mayo considers it a developmental anomaly; Binnie, a primary pericolitis; others have attributed the membrane to inflammation spreading from adjacent organs, appendix, gall-bladder, etc. Hofmeister reports that in 10 out of 14 cases he found the trichocephalus dispar. Connell draws attention to this fact in relation to the suggestion of Metchnikoff and Guirat that cases of peritonitis may be due to the escape of bacteria along the fine passages made by the parasite in the intestinal wall.

Symptoms.—Undoubtedly the condition is present more often than is generally believed. Jackson met with 9 cases in one year. Connell met with 2 cases, showing both an ileal kink and membranous pericolitis. Mayo and others have made similar observations. Jackson gave the essential symptoms as (1) pain, (2) tenderness, (3) constipation, (4) mucous discharge from bowel, (5) meteorism, (6) loss of weight and tone, (7) gastric dyspeptic symptoms, (8) neurasthenia. These, we see, are exactly similar to those given above as suggestive of ileal kink. The identity of the symptoms and signs in the two conditions is admitted by all observers.

Treatment.—Division and excision of the adhesions have been carried out in all cases. Connell has used the twisted adhesion as a supporting band to prevent prolapse of the colon.

ELONGATION AND MOBILITY OF THE CECUM.

In close relation to this discussion of the symptomatology incident to Lane's kink and Jackson's membrane, Wilms has drawn attention

to a group of cases analogous in every respect to those just described, except that he attributes the symptomatology as due to a great mobility of the cecum. It is described as being present in the ordinary cases of enteroptosis. The patient complains of the same group of symptoms as has just been described above. He draws attention to the fact that the length of the cecum is, naturally, subject to great variations. Wilms calls only those cecums abnormally long that can with perfect ease be laid on the anterior abdominal wall. He has by no means infrequently found cecums 10 or 15 c.c. of which could be easily drawn out of the abdominal wound.

These cases were treated by loosening a portion of the peritoneum from the crest of the ileum, by which procedure a sort of pocket is formed in which the cecum is placed. The operation has been performed by Wilms in 40 cases with fairly satisfactory results.

It is thus evident from the discussion of these three views as to the etiology of this group of symptoms that there may be a legitimate reason for believing that the symptoms may be due to any one of the three, or that the symptoms may be due to the accompanying enteroptosis, and only exceptionally due to one of these distinct associated conditions. It is further evident that dogmatic statements cannot be made at the present time as to the proper procedure to pursue and the absolute prognosis that can be given. As a further evidence of the uncertainty of the surgical mind concerning this subject, it may be mentioned that Klose, under the title of "habitual torsion of the mobile cecum," describes the modification of this condition. In his description of the case he draws attention to the same group of conditions already described in discussing Lane's kink, Jackson's membrane, and Wilms' descent of the cecum. He draws particular attention to a firm tumor about the size of a small apple in the region of the appendix. According to him from 20 to 25 per cent. of all cases sent to the surgeon as chronic appendicitis are, in reality, cases of habitual torsion of the mobile cecum.

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CONGENITAL IDIOPATHIC DILATATION OF THE COLON.

(Hirschsprung's Disease—Megacolon.)

Numerous contributions have appeared in the last decade dealing with this subject, and Finney (1908) was able to review over two hundred papers which have appeared since the disease was first described. Since Finney's contribution cases have been reported by Judd, Wagner, and others. The classic study of the literature by Finney, with the tabulated references, offers a complete review of the subject, which is freely used in the following review.

History.—Although Parry (1825) and Billard (1820) reported cases and scattered reports were noted in subsequent years, it was not until the reports by Hirschsprung in 1886 under the name of "congenital idiopathic dilatation of the colon" that the subject began to be generally studied. Since that time the cases have been reported with such frequency that every one should have a clear understanding of the condition and the symptoms and signs necessary to its diagnosis.

Etiology.—Many different hypotheses have been suggested as to the etiology. In general these theories may be divided into mechanical, physiologic, neuropathic, and congenital. Each of these theories has had the support of able contributors. A majority, however, now lean to the congenital origin of the disease. Here, again, however, a difference of opinion arises as to the exact factor originating the process, whether mechanical or neuropathic, or an anomaly of development, a disease *sui generis*.

Barth (1870) suggested that an abnormally long mesentery which would permit of torsion of the sigmoid would most readily explain the condition. Reports of cases, however, have failed to substantiate his hypothesis. The same may be said of Marfan's (1895) suggestion that the etiologic factor lay in an increased length of the colon and a multiplication and exaggeration of its loops. Fenwick (1900) observed a case with a definite contraction of the sphincter ani. Gee, Hitchens, and others have likewise suggested spasmodic constriction as a factor in the production of the condition. Of late years Perthes (1905) contended, on the basis of an observed case, that valve formation in the intestine was responsible for the condition. These may serve as examples of the many suggestions made as to mechanical causes, none of which have satisfactorily explained any number of cases.

An example of the suggestions of a physiologic source is found in the contribution of Walker and Griffiths (1893), who suggested chronic colitis as a cause, this producing gas distention followed by hypertrophy of muscle incident to violent intestinal action. The early age at which cases are observed, coupled with the fact that colitis is a late rather than an early symptom, negatives this assumption.

Lennander (1900), Bing (1907), and others have particularly urged a neuropathic origin, either through the nerves or a segment of the cord. Functional hypertrophy is supposed to take place above the paralyzed segment of the gut. This, however, does not coincide with the known

fact that there is generally a hypertrophy without a segmental paralysis. This theory cannot be discarded lightly, however, since, although we admit the condition to be a congenital idiopathic hypertrophy commonly, we must still admit that isolated cases do seem to be due to one or more of the other factors.

Hirschsprung (1886) was one of the first to classify the condition as a developmental anomaly. He believed that both dilatation and hypertrophy were congenital. Others, while subscribing in general to his views, differ in some particulars. Thus dilatation may be present without hypertrophy. Besides being a congenital disease *sui generis*, we may find developmental anomalies of the intestinal tract which may act mechanically, producing the condition (Concetti). Other parts of the body are frequently the seat of coincident anomalies.

It is seen from this general discussion that cases may be divided into two types: those occurring in infancy (true Hirschsprung's disease); those occurring in later life (pseudo-Hirschsprung's disease). It is probable that almost all true cases will fall in the former group, which is an apparently typical clinical entity.

Pathology.—In more than one-third of the cases the sigmoid flexure is involved. The whole of the large intestine may take part in the process (15 per cent.), while the rectum and small intestine are rarely involved. The dilated portion may reach 6 inches in diameter. Its capacity may be astounding. Formad's case contained 40 pounds of feces. The walls of the intestine show marked change. The teniæ of the serous coat may be obliterated. The mesocolon is often greatly thickened and may contain lymphangiectases (Finney). The mucosa is frequently pigmented (Judd). Microscopically we see an hypertrophy of all the muscular tissue.

Symptoms and Signs.—The patients give a history of an obstinate constipation beginning in early life. The bowels move only with enemas or cathartics, or no bowel movement may occur for weeks (eight to ten in some cases). This is followed by a period (one to three days) of diarrhea. Upon examination one observes the dry, harsh skin, probably emaciation, and particularly the distended abdomen. Sometimes the intestinal coils may be seen and palpated. Marked disturbances of adjacent organs may be seen. Enemas will bring away large masses of feces, thus confirming the diagnosis. An *x*-ray picture of the colon injected with bismuth may further substantiate the diagnosis.

Prognosis.—Little or nothing is to be hoped for from conservative treatment, although it should be tried in the very young. Surgical intervention gives the most satisfactory results. If untreated, the patient becomes a chronic invalid, subject to digestive disturbances and its complications.

Treatment.—Medical.—In the very young or in mild cases the usual treatment instituted for constipation has been tried with slight success, *i. e.*, enemas, massage, exercise, regulation of the diet, etc.

Surgical.—This has varied with individual surgeons. The procedure giving the best results is undoubtedly resection of the distended

loop, either by a one- or two-step operation. Some would produce an enterostomy, either above the dilatation (Finney) or in the upper end of the dilated portion. After some weeks of irrigation and nutritive treatment the dilated part is resected. Colopexy, coloplication, permanent colostomy, entero-anastomosis, and various other procedures have been carried out in individual cases, but they probably have little to recommend them over resection except in isolated cases.

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GAS-CYSTS OF THE INTESTINE.

Finney[1] has described a gas-cyst of the intestine. In his case, the first reported in America, the tumor sprung from the ileum and consisted of a multicolored cystic growth, the spaces of which were filled with gas. He attributes the gas to cellular action.

RUPTURE OF THE INTESTINE.

In addition to the various articles which have appeared in the last decade urging immediate laparotomy in cases of suspected rupture of the intestine, one of the most important contributions has been made by E. Wyllys Andrews,[2] in which he draws attention to an entirely unique form of industrial accident, and reports 14 cases in which it has occurred. It consists essentially in a rupture of the gut incident to the introduction of compressed air into the rectum. Andrews describes the condition and discusses it as follows:

"**General Observations.**—Compressed air is used very generally to transmit power for drills, riveters, and small tools, for cleaning cars, engines, barrels, etc., so that many large manufacturing concerns have it piped about their buildings and grounds. The air is supplied at from 40 to 125 pounds' pressure, and flexible hose connections are attached to the pipe lines at various stations. So many of the above reports speak of 'initiating' or 'hazing' the workmen by their fellows with the air nozzle, that this form of the practical joking mania must be common. It may be that many minor or trivial accidents have happened which are not reported, but of this I can get no information.

"**Mechanism of the Injury.**—In all the cases cited the air had to pass through one or two layers of cloth to enter the anus. Yet this did not seem at all to restrain or delay its deadly work. In several cases it is stated that the nozzle was an inch or more distant and not touching the body. I feel sure that at 50 to 125 pounds' pressure a gas would form a column several inches in advance of the tube, which would act almost like a solid body in forcing open the sphincter. One has only to

[1] Jour. Amer. Med. Assoc., li., p. 1291.
[2] Surg., Gyn., and Obst., Jan., 1911.

hold the hand near such a nozzle to realize the tremendous impact of the blast. Just as the jet of a fountain can be made to sustain a ball of some weight, so the jet of air is more than ample at several inches to force the levator and sphincter ani muscles and soft pelvic floor. The pelvic floor and nates form, in fact, a funnel whose apex is the anus. The confined air expanding in this funnel will force the gut open without having the end of the pipe accurately adjusted to the anus. With the involuntary contraction of the levator and sphincter muscles the space between the buttocks would be narrowed and the funnel deepened, thus confining the escaping air laterally and leading it the more quickly into the bowel.

"**Pressure Required to Rupture an Intestine.**—With an air-pressure gauge and tank of compressed air it is easy to show that the ordinary bursting point in a dog or ox intestine is from 6 to 10 pounds. The human intestine shows about the same bursting point when removed from the body. Whether the strength would be greater in the living body we do not know, but probably there would be a slight difference.

"**Symptoms and Pathology.**—Several of the reports speak of minor bruises about the anus, but in most the injuries are internal and concealed. It is notable that no case has been diagnosed without a history, most of them being treated as "colic." This is no more than is true of traumatic rupture of the bowel from blows, in which a diagnosis could not be made early on objective signs only.

"The rectum and anus escape much injury because of their outside support. The sigmoid tears probably because it is first to receive and confine the blast of inrushing air. The wide loop of the sigmoid flexure probably traps the air momentarily by its somewhat bent or kinked junction to the descending colon. It thus sustains the first shock of the diastatic pressure, and, unable to pass the mass of air onward, it yields to the pressure, dilates, and bursts into the free peritoneal cavity. In testing the intestine with the air-pump and gauge the rupture often takes place in the mesenteric border, but in all the cases here reported except Steven's it is reported as occurring at the longitudinal band, if mentioned at all.

"**Mortality and Prognosis.**—The mortality in the above cases was 13 or 81.2 per cent., but this is largely increased by the fact that no operation was done in most of them. Of the 7 cases treated by laparotomy, 4 died, or 57.2 per cent. Of 9 cases not operated, all died, or 100 per cent. If all cases could be brought to early operation the mortality would be lower—10 to 25 per cent.

"**Treatment.**—It seems useless to speak of palliative treatment; yet palliation of the one symptom of air-pressure by puncture did resuscitate my case, and enabled me later to do a laparotomy. Ambulance surgeons, or those giving first aid, should be instructed, if great dyspnea is a factor, to make an emergency tapping with a hollow needle or even a small bistoury. Regular laparotomy should be performed as soon as possible."

INTESTINAL OPERATIONS.

Colostomy.—A constantly discharging colostomy wound is a source of annoyance to both patient and surgeon in all cases, and many suggestions have been made as to methods which may avoid this unfortunate condition. Lilienthal has described the method he has used in several cases with considerable success. The essential feature of this method consists in making an incision through the body of the left rectus muscle. The gut is brought well out of the opening and severed. The proximal end is well mobilized and sutured to the peritoneum by a continuous suture with about 3 inches of the bowel outside. The gut is then rotated on its axis after the manner described by Gersuny, from 180 to 360 degrees, the amount of rotation being determined by the finger inserted in the lumen. When the opening is occluded the rotated gut is then sutured to the aponeurosis so as to hold it in the new posi-

FIG. 261.—TWIST COMPLETE AND MAINTAINED IN POSITION BY ANCHOR SUTURES HOLDING SIGMOID TO APONEUROSIS. (Lilienthal.)

tion. A rubber tube is inserted and held in the gut lumen by sutures to drain the contents of gut temporarily. The distal end of the cut gut is fixed in the lower end of the wound, drainage provided, and the abdominal wall closed between. The bowel is washed out where necessary. The patient soon learns to control the bowel movements, particularly if the contents are kept solid by bismuth or tincture of opium.

Marro attempts to produce a like satisfactory state by bringing a loop out, mobilizing the proximal end, and carrying it through the abdominal wall at the site of a second opening at the side of the left rectus. Instead of continuing it through the entire wall, however, the gut, after coming through all the layers up to the skin, turns sharply upward and is carried through a subcutaneous canal to make its exit through the skin 3 or 4 inches higher up. An essential feature of the procedure is that the subcutaneous part should be so placed that a band (of the

underwear, for instance) drawn tightly about the waist above the crest of the ilia will compress the gut and thus prevent too free extravasation. He reports 3 cases operated upon with success by this method.

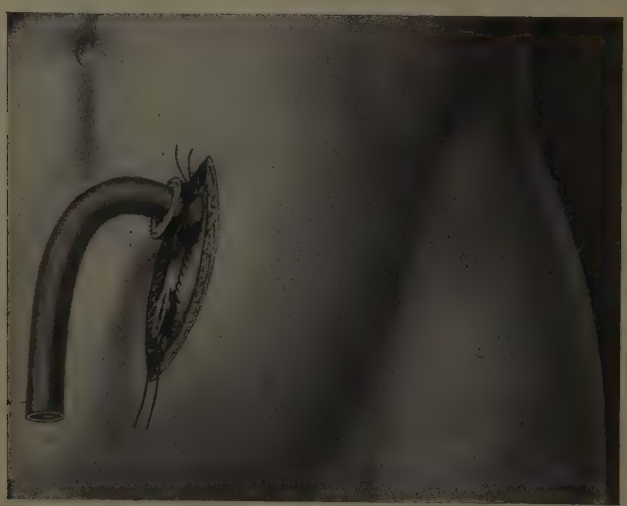

FIG. 262.—OPERATION COMPLETE. APONEUROSIS FURTHER STITCHED TO INTESTINE AND WOUND CLOSED WITH THE EXCEPTION OF THE SKIN. (Lilienthal.)

Ryall has suggested another method by which the proximal end is brought through the rectus. The artificial sphincter is made as follows: A loop of muscular fibers is separated from the posterior aspect

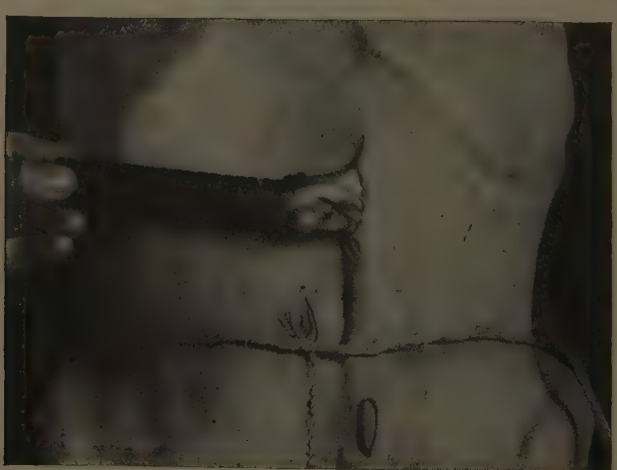

FIG. 263.—PHOTOGRAPH OF CONDITION PRODUCED IN ONE OF MARRO'S CASES. (Marro.)

of the rectus on either side of the wound. Each loop is then drawn over to the opposite side of the wound, so that one loop overlaps the other. The overlapping loops thus form a ring and through this the bowel

segment is drawn. A double sphincter is thus formed, consisting of longitudinal and circular fibers coming from the anterior and posterior aspects of the rectus respectively.

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Marro: Annals of Surg., liii., 250.
Ryall: Lancet, July 3, 1909.

Fistula.—That closure of intestinal fistula may be a matter of difficulty is well known. Where direct closure is difficult or dangerous, Coffey has suggested excising the tract down to the peritoneum and then closing the opening by inversion. The abdominal wall is closed in layers over the fistula, and drainage down to the peritoneum is provided for at a distance from the wound by making a new stab incision down to the peritoneum and inserting tubes or gauze, so that the leakage, if it occurs, will follow a tortuous canal and thus tend to close.

Berg has suggested and carried out in 2 cases of duodenal fistula a gastro-enterostomy, accompanied by occlusion of the pylorus. This prevents the rapid starvation of the patients, which is a complication in these high-seated fistulæ by short-circuiting the food, and also favors closure of the fistula. It would seem that the transgastric jejunal feeding suggested by Schwyzer might be of distinct aid here. After the gastro-enterostomy is done, a tube is inserted into the anterior stomach wall and down into the jejunum through the gastro-enterostomy wound. Thus all possibility of food entering the duodenal loop is prevented.

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Coffey: Annals of Surg., vol. xlv., p. 827.
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Intestinal Anastomosis.—Among the complications that arise in intestinal anastomosis, one of the most embarrassing is that in which, owing to disease or position, a lateral or end-to-end anastomosis by direct suture is impossible. This is most commonly found in resections of the lower part of the sigmoid and upper end of the rectum, where it may be most difficult to reach the distal end. To meet this emergency Mayo has suggested inserting a rubber tube out through the rectum and attaching its upper end inside the proximal or sigmoid lumen by a catgut suture. Traction upon this draws the sigmoid gut inside the rectal gut. The edges are now sutured by a continuous suture. Further traction on the tube invaginates the upper gut and the line of suture into the rectal gut, when a second row of peritoneal sutures completes the operation. Gibson in similar conditions has telescoped the proximal gut into the distal loop and sutured around.

Grant has carried the procedure even farther, in that in his case he telescoped the gut out through the rectum and inserted a tube into the bowel for drainage. Noble has, however, suggested a mechanical

device which obviates the difficulty in the low sigmoid cases. He calls it the anastomat. In consists of two tubes 7 inches in length by $\frac{3}{4}$ inch

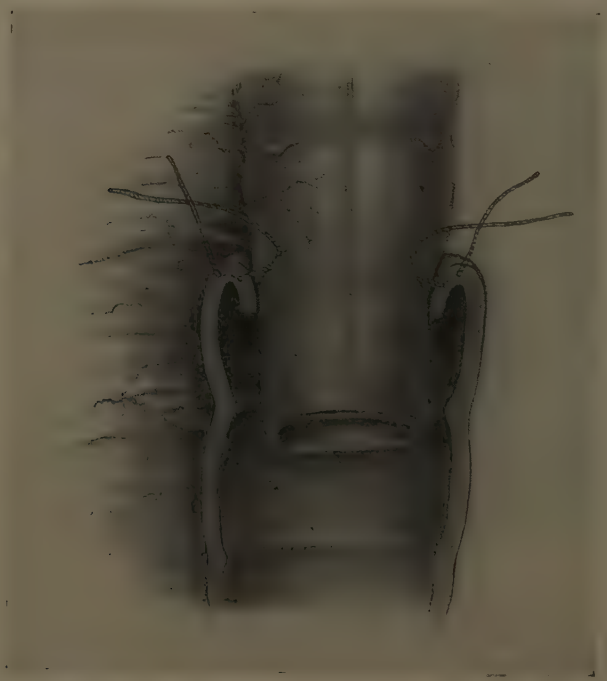

Fig. 264.—Interior View of Invagination. (Gibson.)

in diameter, one tube fitting closely within the other. Attached to one end of each of these tubes is what is practically half of a Murphy

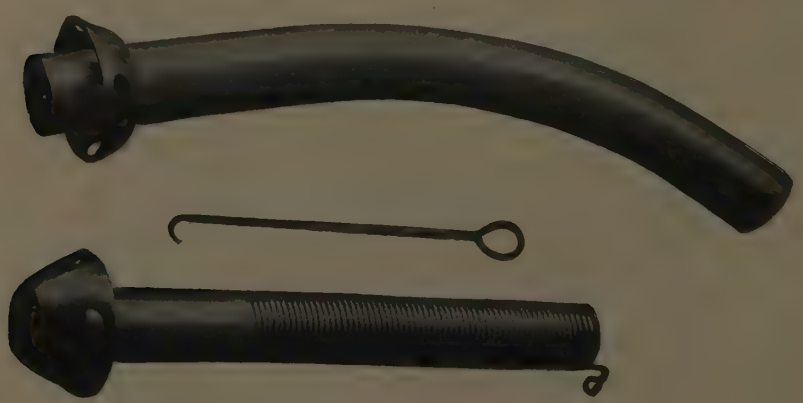

Fig. 265.—Baldwin's Modification of the Noble Anastomat.

button, so that when these tubes are placed the one within the other the two halves of the button can be approximated and the anastomosis

completed. The inner tube projects beyond the outer and has threads cut so that a screw can be turned down to secure firm apposition. As healing takes place the screw is turned down a few threads until the whole device becomes detached and can be withdrawn through the anus. In using it the outer tube is passed from above down through the rectum and out at the anus. With a purse-string suture the upper end of the rectum, after the resection is completed, is gathered in as around a Murphy button. The inner tube is similarly connected by purse-string to the lower end of the remaining portion of the sigmoid, and then, as the inner tube is slipped in and through the other, the intestinal ends are approximated and brought together as with a Murphy button. By this device an anastomosis may be made very easily which would be impossible by other

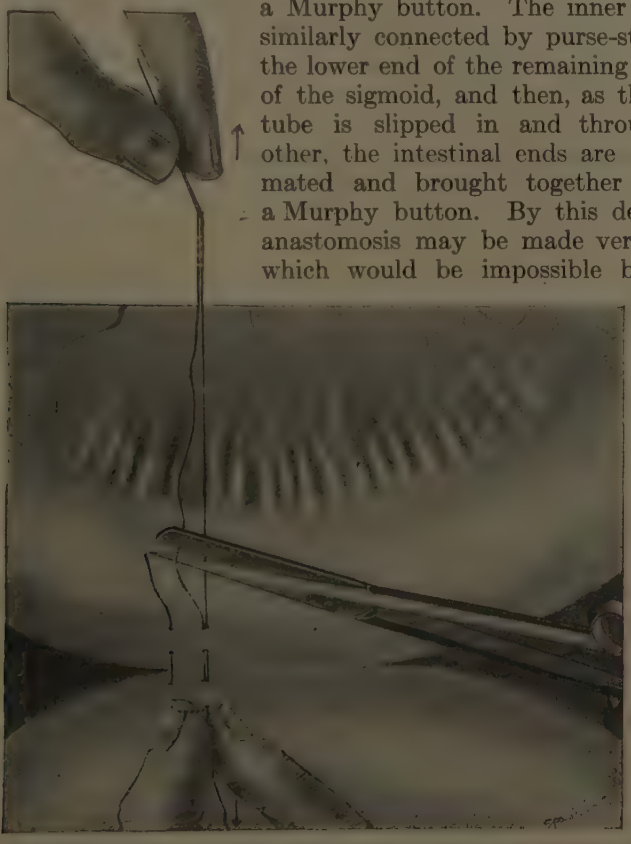

FIG. 266.—THE TWO STRANDS IN THE SECOND SET OF STITCH-HOLES; ALSO SHOWING THE METHOD OF PULLING ON THE TAIL THREAD, SO THAT THE STRAND FORMING THE SECOND LIMB OF THE MATTRESS MAY BE CUT. (After Turck.) (Lahey.)

This illustration also shows plainly how one mattress stitch and one-half of the next mattress stitch are inserted at one time.

methods, while the tube secures good drainage and the opportunity to flush out the bowel.

Baldwin has modified this by making the tube curved and using, instead of Noble's screw, an inner tube cut into a spiral, so as to furnish a spring of proper tension. To this is attached a hook which catches over the lower end of the outer tube.

Among the many suggestions made as to suturing the bowel, that of Crile is worthy of especial mention. He has described a stitch which

he calls the cobbler stitch. It is used in the entero-anastomosis, and consists essentially in the use of two sutures carried through after the manner of the well-known cobbler stitch. It is carried out as follows:

The introduction of the first half of the suture is accomplished by passing simultaneously two needles, one grasped in each hand, in op-

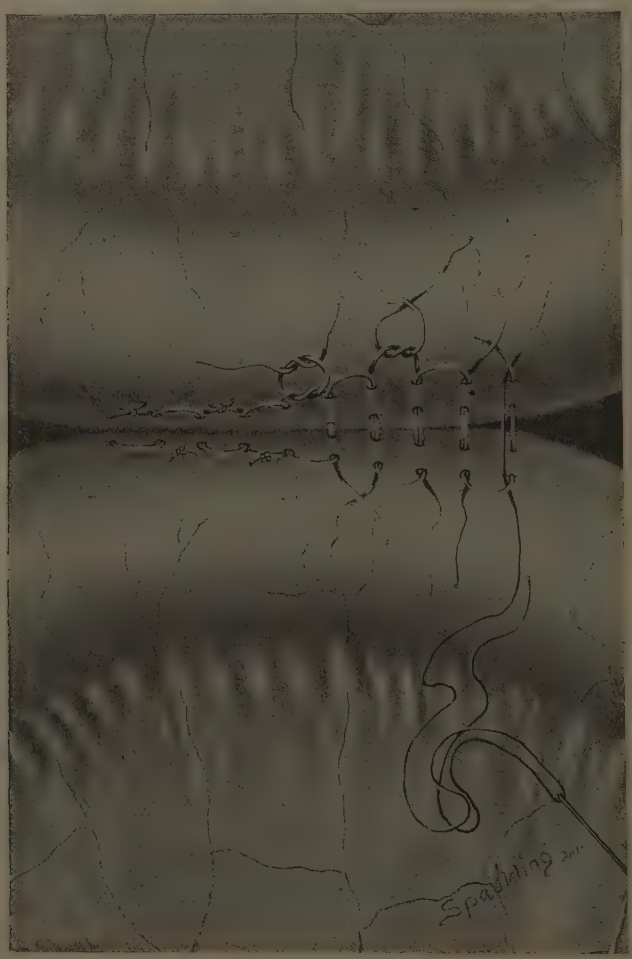

FIG. 267.—MANNER IN WHICH THE STITCH LOCKS IN THE STITCH-HOLES; ALSO STITCHES LOCKED AND TIED. (Lahey.)

At the right end of the suture is shown how a new suture is locked into the suture before it. In the same manner the last suture is locked with the first in completing the circuit.

posite directions, through and through. The insertion of the second half of the suture may require a little practice to form the habit of retracing the track of the first needle by the second in the opposite direction. . In this part the needle must be passed separately, but it matters not which is passed first, so long as the other is passed through

the same track in the opposite direction. Complete inversion of the walls necessarily occurs as the sutures are drawn snugly.

Lahey has described an interlocking intestinal suture that has certain advantages over Sugg's and Turck's interlocking sutures. The ordinary intestinal needle is threaded with a good-sized piece of paraffined linen, or whatever suture material may be chosen, one end being pulled out so that it is slightly longer than the other; the needle is then inserted in the Lembert fashion, first through one piece of intestine and then through the other, so that, when pulled through, but for an end, the stitch consists of but one strand; the needle is again inserted as for the ordinary mattress suture and emerges on the side from which it started, but when the thread is pulled up the suture in the second set of holes contains two strands of thread, owing to the unevenness of the ends when the needle was threaded. There is now a simple mattress suture with one loose end and a double end within the needle, and another loose end on the opposite side of the stitch (Fig. 266); this latter loose end is now grasped with the fingers of the left hand (Fig. 266) and pulled gently, the needle being held in the fingers of the right hand so that the thread between the two hands is taut, with the result that the double strand of thread on the needle side of the wound separates and one strand bellies out close to the wound, the other remaining straight and taut, as is shown in the illustration. Now if the assistant cuts the strand which bellies out (Fig. 267) it will be found to be the second end of the mattress suture, and will leave one mattress suture and one-half of another already inserted. The loose end which has just been cut is now carried once around its mate (the uncut suture), thus providing for the lock when the next suture is applied. As the next step the needle is slid back along the thread a short distance, in order that, when the needle is again inserted for another mattress, the end will stick out, so that it may be grasped as in the previous case. The second limb of the mattress is now made, and, as in the first case, there is a double strand in the stitch-holes. Again, the loose end of the double strand is pulled on by the fingers of the left hand, the needle being held in the right; the assistant cuts the thread which bellies out; again the suture is carried around its mate to be interlocked, and again the needle is slid back for the next stitch, and the process repeated until the circuit is completed. The manner of inserting a second suture and of locking the last suture in completing the circuit is shown in the illustrations.

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CHAPTER CXXVI.

THE SURGERY OF THE VERMIFORM APPENDIX.[1]

By John B. Murphy, M.D.,
Chicago.

Anatomy.—In the original article (Vol. IV., p. 730) the length of the appendix was given as from 1 to 9.5 inches. To this may be added a case reported by A. Patel measuring 10 inches. It was peculiarly shaped at the base, was nearly the same diameter as the ileum, then gradually narrowed until about the middle, where it was of the usual size, resembling the elongation of the cecum in canines.

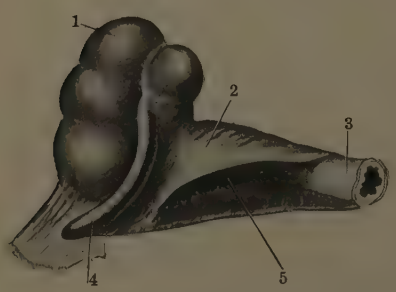


Fig. 268.—The Ileocecal Fold. (After Treves.)
1, Cecum; 2, ileocecal fold; 3, ileum; 4, appendix; 5, ileocecal fossa.

Sir Frederick Treves (Fig. 268) described a bloodless fold of peritoneum extending from the free border of the ileum to the meso-appendix. While this fold is absent in 10 per cent. (Berry), on the other hand, it occasionally is found unusually developed; a well-marked example of this has been described by Battle (Fig. 269). In this instance the ileocecal fold was so extensive that it formed a third omentum, which Little, many years ago, called "the ileocecal omentum." The presence of this anomaly may somewhat complicate operative procedures.

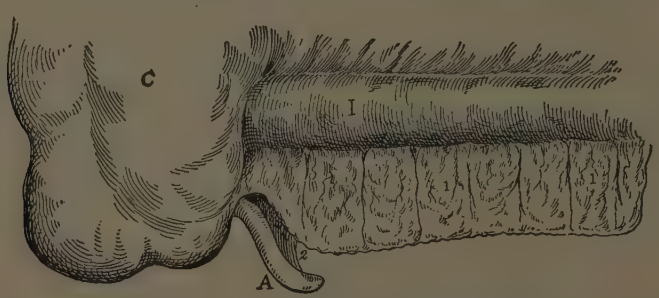


Fig. 269.—The Ileocecal Omentum. (Battle.)
A, Appendix; C, cecum; I, ileum; 1, thin double layer of omentum containing vessels and fat; 2, meso-appendix.

[1] Supplementary to Chapter LXIII., Vol. IV., p. 727.

Attention was also called in Vol. IV. to the fact that the blood-supply of the appendix is precarious. The principal source is the appendicular artery, and though there are anastomoses with the cecal artery, these are too small to do much good if called on suddenly. As the appendicular artery courses in the meso-appendix, if the latter does not extend to the tip the terminal portion is, of course, poorly supplied with blood. The appendicular blood-supply is commonly a circular one.

Yeomans discusses the blood-supply in relation to appendicostomy, which operation lately has become popular. If the anastomosis referred to is very free, either branch could be tied without undue consequences. At operation, however, one cannot be sure of this, so the safest plan is to preserve both the cecal and appendicular vessels (Fig. 270). There is no difficulty in avoiding the former when joining the appendix to the parietal peritoneum, as both are evidenced by visible pulsations.

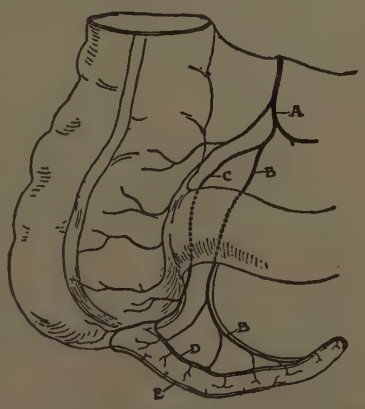


FIG. 270.—BLOOD-SUPPLY OF APPENDIX. (Yeomans.)

A, Posterior ileocecal artery (partly schematic); B, appendicular branch; C, cecal branch; D, constant, and E, variable branches from cecal branch to appendix.

It is difficult with the appendicular artery itself, since most diseased appendices are curled up on account of the shortness of the meso-appendix, and the latter must be freed so that the appendix can be straightened to admit of the free introduction of fluid. There are two methods of accomplishing this: The first insures a viable organ up to the surface of the skin, but the procedure is open to the objection that there is early gangrene of the tip, and infection is apt to extend from the appendix to the abdominal wound. Appendicostomy is performed by ligating and cutting the mesentery at a point sufficiently distal from the base, so that the blood-supply to that portion of the appendix which traverses the abdominal wall is preserved.

The other method preserves the vessels intact, yet allows the appendix to be straightened sufficiently. It is carried out by separating the two peritoneal layers of the mesentery at its junction with the posterior parietal peritoneum, " beginning at its free border, and carefully displacing the cellular tissue with its contained appendicular artery and branches as far as necessary toward the appendix. The layers of peritoneum are divided transversely up to the base of the appendix, turned in, and sewed to obliterate the raw space on the posterior abdominal wall."

Several years after the description of McBurney's point, Lanz noticed that the anterior superior spines were joined by a fold in the skin. He decided (for esthetic reasons) to use this fold as the site for the incision in appendectomy, an incision analogous in principle

to Kocher's "collar-incision" for goiter, and which Lanz named the "girdle-incision." Carrying this out on some of his cases, he found that the appendix was exposed more satisfactorily than with the usual oblique incision. Pursuing his investigations, he endeavored to map out the location of the organ by palpation, then, marking the skin, compared this with the findings at operation (Fig. 271). As a result, he concluded the appendix does not, as a rule, correspond to McBurney's point, but to the bispinal line, at the junction of the outer and middle thirds (and, as we have shown, directly under the linea semilunaris).

One of Lanz's assistants carried out some investigations on 20 cadavers, and corroborated these findings. Wires were inserted in the skin at McBurney's point and also at Lanz's point; after opening

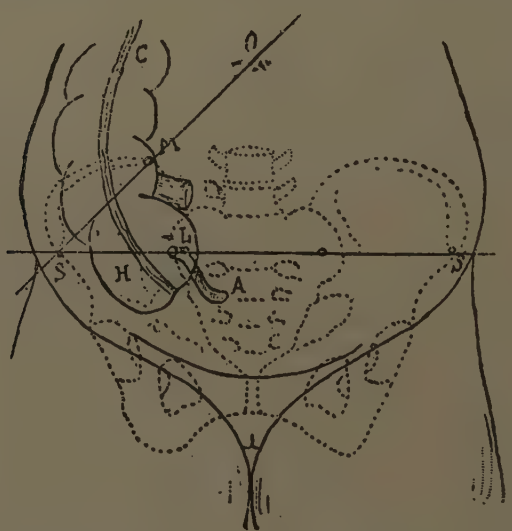


FIG. 271.—RELATIVE SITUATIONS OF MCBURNEY'S AND LANZ'S POINTS. (Garau.)
A, Appendix; C, ascending colon; H, cecum; L, Lanz's point; M, McBurney's point; O, umbilicus; S, anterior superior spine.

the abdomen it was found that in nearly all cases the wire at Lanz's point corresponded to the base of the appendix. The one over McBurney's point, on the contrary, was located, as a rule, over the inner border of the ascending colon, about $1\frac{1}{2}$ or 2 inches above the base of the appendix. (Of course, these findings do not preclude the fact of pain being referred to McBurney's point.) In 85 subjects examined by Liertz the appendix was near McBurney's point in but 6; in 69, near Lanz's point; in the remainder the viscera were more or less misplaced and neither was available.

Still more evidence as to the accuracy of Lanz's point has been furnished by Garau, after numerous researches on the cadaver. This observer found that in 11 per cent. of the subjects the base was closer to McBurney's point; in 2 per cent. it was midway between this and

Lanz's point, and in 87 per cent. closer to the point described by Lanz. He agreed with the last author that McBurney's point does not exactly correspond with the base of the appendix, but with the inner median portion of the ascending colon, about $1\frac{4}{5}$ to 2 inches higher up. The usual site of the appendix is on the bispinal line exactly between its outer third and inner two-thirds; hence Lanz's point is the true landmark of the appendix, and every incision to expose the organ must pass through this point.

McBurney's point, however, still retains its value from a symptomatic standpoint. It is the third in order and importance in our "quintet" of symptoms of appendicitis—pain, nausea and vomiting, local sensitiveness, elevation of temperature, and leukocytosis. If the seat of the pain is not that of the diseased organ, what is the mechanism of the pain at McBurney's point? Some observers believe it is due to excitation of the sympathetic ganglia in the vicinity; others, that it originates in inflamed lymph-nodes over which the examining finger passes. Lennander thought it was caused by lymphangitis spreading from the appendix to the neighboring structures.

According to Garau, the most logical theory is that of Meisel, who believes the point in question is merely the cutaneous area corresponding to the spinal segment to which run the sensory nerves of the ileocecal junction with the appendix. The *modus operandi* is the following: In the normal condition there is a transmission of sensory impulse to the ganglionic cells on the posterior spinal nerve-roots: this is transmitted through the efferent nerves to a corresponding peripheral sensory cutaneous zone analogous to the subscapular pain associated with cholelithic colic, showing the viscerosensory surface reflex, and is reflected to the McBurney point on the right side, whether the inflamed appendix be found in the right, left, or any other position in the abdominal cavity. (See case of Sokolova, p. 544.)

We may, therefore, conclude that McBurney's point is nothing but the parietal nervous distribution of the afferent nerves coming from the appendix, and it is thus easily seen how, by exerting pressure at this point, a painful exacerbation is produced, especially as we thus excite increase of the intracecal pressure and compress or stretch the adhesions which may be formed, the latter themselves being a cause of the increased intensity and duration of the nervous impulses already abnormal by reason of the infectious process which has placed the walls of the appendix under great tension.

In this connection it may be pointed out that Capellen (in Lanz's clinic) examined 119 patients at least a month after appendectomy, and found McBurney's point was still tender in 26; a well-recognized clinical phenomenon of great annoyance to the patient and disconcerting to the surgeon.

The cecum with the appendix is located on the left side in cases of transposition of the viscera, or may be found there when these organs have not undergone the usual embryonal revolution, while the rest of the viscera occupy their customary position. Hebblethwaite records

a case of the former anomaly in a boy of sixteen. A median incision failed to locate the appendix, and, as the viscera were transposed, a second incision was made on the left side which exposed the organ.

A typic case of left-sided appendix without *situs inversus* was met with by Sokolova. A woman of nineteen had violent pain in the *right iliac fossa*, with the usual symptoms of peritonitis. On account of the persistent pain on the right side, with absence of symptoms referable to other organs, a diagnosis of appendicitis was made. Immediate operation. A long incision in the right iliac fossa disclosed no traces of the cecum, the sigmoid described a much more marked curve than usual to the right. A stab-wound was made on the left for drainage, and after the pus was evacuated the cecum came into view, and by twisting it slightly the terminal ileum was seen; *the appendix was situated on the left side, behind, adhering to some loops of small intestine.* Death later. At the necropsy the ascending colon was found running from the left iliac fossa to the splenic region; here it turned on itself to form the descending colon and sigmoid; the transverse colon was completely absent. There was a common mesentery for both the large and small bowels.

FIG. 272.—MALPOSITION OF CECUM AND APPENDIX. (Bland-Sutton.)

The cecum, after undergoing torsion and passing behind the mesentery, occupied a position in front of the left kidney.

Occasionally the cecum is arrested in its embryonal downward migration and the appendix is found high up. Thus, in a case narrated by Kickland, in an operation for appendicitis the gridiron incision was used, the large intestine was drawn out from the pelvic end, and search for the appendix made by following up the longitudinal band of the colon. The lower end seemed so deep that suspicion was aroused, and the introduction of a rectal tube showed it was the sigmoid and not the cecum. The wound being enlarged, the cecum and inflamed appendix were discovered lying under the liver.

Another case is referred to by Bland-Sutton. A man aged forty-eight had symptoms pointing to obstruction. At laparotomy attention was first directed to the right iliac fossa, but the cecum and appendix were absent. A tense band of gut extended from the right end of the mesentery up and to the left, overlapped by mesentery and coils of intestine (Fig. 272); traced up, this was found to lead to the

ileocecal junction in the left kidney pouch. A loop, made up of the last few inches of the ileum and ascending colon with the cecum and appendix, had been twisted on its own axis through 180 degrees and displaced upward as well as to the left, following the direction which pus occasionally takes through the submesenteric route to the left kidney. (See Vol. IV., p. 747.) The cecum had then become adherent in its new location.

In other instances the cecum does not stop at its usual site, but continues on downward. Alglave encountered a case of this nature in a dissecting-room subject: A male, aged forty-six; the cecum was found in a fossa with muscular walls $\frac{3}{4}$ inch deep between the psoas and iliacus; the mouth of this fossa was on a level with the iliac crest and the apex at the middle of the iliac fossa. Both cecum and appendix were lodged under the psoas, the latter, in turn, being covered by the iliac fascia. The left side of the cecum rested directly on the iliacus muscle; its right side was rolled up, forming the posterior wall of a complete peritoneal sac between it and the under surface of the psoas. This diverticulum from the peritoneum was 3.2 inches deep by 1.6 inches wide, opening above into the iliac fossa, and by inserting the finger into it the tip of the appendix could be felt deep down.

In an interesting case of Pohlman the appendix communicated with the duodenum. This was also a dissecting-room finding. In a male negro the cecum was situated a trifle higher up than usual, and found attached to the transverse duodenum by a dense adhesion which was preserved as a possible appendix. On opening it a canal was found with a lumen throughout of $\frac{1}{12}$ inch and a length of $1\frac{1}{2}$ inches. The distal opening passed obliquely through the wall of the duodenum, being covered by a pocket of mucosa. Pohlman believes this was a case of downward displacement of the duodenum coming into contact with a retrocecal appendix. The structures were then anchored together as a result of chronic peritonitis, and, finally, there was ulceration of the duodenum perforating into the appendix.

Appendices which have become misplaced and bound down in their new position are frequently met with adherent to gall-bladder, uterus, ovary, tubes (right and left), ovarian and dermoid cysts, etc., as in cases reported by Murphy, Mayo, Cole, Quigley, Deaver, Morris, and others.

Diagnosis.—Additions to our now classic *symptoms and means of diagnosis* of the disease are not very noticeable.

Rovsing, the well-known Danish surgeon, announced a few years ago that pressure along the descending colon may cause pain at McBurney's point in cases of appendical disease. Notwithstanding that he made observations in over 100 cases, his deductions have not been sustained by the experience of Lauenstein, Hoffman, and many others.

Wilson, of the Mayo clinics, speaks favorably of the value of Sondern's differential leukocyte resistance line in the diagnosis and prognosis of acute appendicitis. He states that Sondern's hypothesis that the polynuclear percentage is an index of infection and the total leu-

kocytosis an index of body reaction, and their proportional relationship as an index of resistance, seems to be supported. From my own experience the percentage of polynuclear cells represents *the efficiency of the systemic defense against virulent infections rather than an indication of the virulence of the infection, as the polynuclear cell carries the trypsin ferment so valuable in the destruction of infected flora.* Moribund cases and, perhaps, children form the more important exceptions to this. As practically applied in early cases the disproportional polynuclear increase—*i. e.*, a rising resistance line—indicates a more or less severe infection which is not being properly cared for by the body. The higher

FIG. 273.—"FIST PERCUSSION OF THE KIDNEY."

and longer this line, the more serious the case. A proportional polynuclear percentage or a disproportionate polynuclear decrease if well marked indicates mild or well-cared for infection.

However, the value to the surgeon in early cases is but little, since most of such cases are operated on any way. It may be of some value negatively in indicating that the supposedly acute exacerbations of chronic appendicitis are really not present. In cases between the fourth and fourteenth days the line is very valuable as an indication of the patient's poor resistance and necessity for immediate operation. Operative findings in such cases bear out the leukocyte determination

with wonderful accuracy. In cases like those just mentioned, a horizontal or falling line indicates the patient is taking care of the infection. If the latter is severe, as shown by a high though falling line, the patient may perhaps be given medical rather than surgical treatment. When such a case is kept under observation, the line should be determined each day; and should it start to rise, the patient may be subjected to operation.

Volkovitsch directs attention recently to a supplementary diagnostic sign. In chronic forms following repeated acute attacks there is a local-

Fig. 274.—"Fist Percussion of the Kidney."

ized atrophy of the abdominal wall over the location of the appendix. This has only a minor value.

The differential diagnostic signs of the four most common lesions in the right abdominal cavity, namely, gall-bladder, renal, appendical acute disease, and perforations of the gastro-intestinal tract, as devised and used by Murphy in his clinic for many years, are given by Guy G. Dowdall as follows:

The first is what has been called by Murphy the "fist percussion of the kidney," and is used to determine the presence or absence of an acute pathologic condition within that organ, as obstruction to the pelvis or ureter (Figs. 273, 274). As shown in Fig. 273, the patient, with

clothing removed above the waist, is seated in an upright position on a stool, and is then instructed to bend forward as far as possible. With the patient in this position the examiner, from behind, places his left hand flat upon the back of the patient over the suspected kidney, care being taken to have the hand pressed firmly upon the back. The clenched right hand of the examiner is then brought down with considerable force upon the dorsum of the fixed hand (Figs. 273, 274), and if an acute congestion, infarction, retention in the pelvis of the kidney, or ureteral obstruction exists in that kidney, the patient will

FIG. 275.—"HAMMER-STROKE PERCUSSION."

cry out with the pain of the blow. It is analogous to striking over a distended urinary bladder; and if an acute pathologic condition be present the result will be unmistakably apparent. A good sharp blow is used, but it is not necessary to use force enough to aggravate any diseased condition within the kidney. A control test is advised by first using the blow on the sound side and then on the suspected side.

A second method, and one depending upon the same principle as the preceding one, is used by Murphy in his examination for an acute infection of the gall-bladder or acute obstruction of the cystic or com-

mon duct, with or without infection. The examiner, sitting at the right side of the recumbent patient, presses the tip of the second finger of the left hand, flexed at a right angle, firmly up under the costal arch at the tip of the ninth cartilage, as shown in Fig. 275. The patient is instructed to take a deep breath, and at the height of the inspiration, when the gall-bladder is forced below the costal guard, the flexed finger is struck forcibly with the ulnar side of the open right hand of the examiner, and if there be an inflammation or a retention in the biliary tract the patient will announce that the blow caused him severe pain. One is again striking an overdistended or inflamed viscus that contains sensitive nerve-filaments. Murphy calls this the "hammer-stroke percussion." The force used in striking the finger is well shown

Fig. 276.—"Hammer-stroke Percussion."

in Fig. 276, for here one sees that sufficient force was used to sink the finger well up under the costal arch.

Another method designated by him as the "deep-grip palpation" is somewhat similar to the above, and is also used in an examination of a suspected gall-bladder disease. It is based upon another mechanical method of squeezing the gall-bladder, depending upon the diaphragm to tell the story. Standing directly behind the patient, as in the accompanying photograph (Fig. 277)—provided the patient is well enough to assume an upright position; if not, the examiner reaches over the recumbent patient from the head—the right hand of the examiner curls up under the costal arch at the tip of the ninth cartilage, the patient is requested to take a deep breath, and, at the end of the expiration, the examining fingers seek the gall-bladder area and fix it

from beneath. The diaphragm, descending from above with the beginning inspiration, brings down the liver and gall-bladder, and if a cholecystitis or cholelithic obstruction is present the descent is checked suddenly with an accompanying groan from the patient, for the diaphragm, acting as the great piston of respiration, forces the distended, inflamed, or congested gall-bladder down upon the firmly fixed hand, and the result is an abrupt cessation of the inspiratory act, plainly shown by the patient, for he feels a severe pain.

Still another method used by Murphy is called by him the "piano percussion." It is used to demonstrate a small quantity of fluid from

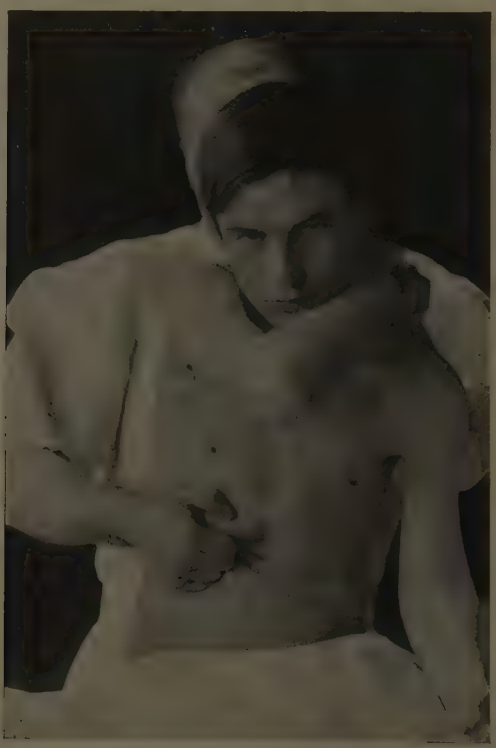


FIG. 277.—"DEEP-GRIP PALPATION."

perforation or exudate in the abdominal cavity, resting on the hollow viscera, the intestines, and is based upon the peculiarly characteristic percussion note given off when the abdominal wall over the fluid is struck by the four fingers one after the other, beginning with the fourth and rapidly going to the index-finger (Figs. 278, 279, 1, 2, 3, 4). There is a complete absence of the tympanitic note which one gets in this condition when the ordinary percussion methods are used, for with the usual percussion stroke the tympanitic note from the distended bowel so obscures the faint flat note coming from the fluid that the latter is entirely lost. This "piano percussion" is so superficial a stroke,

or, rather, series of strokes, falling almost simultaneously that only the flat note from the fluid is brought out. It is a somewhat delicate

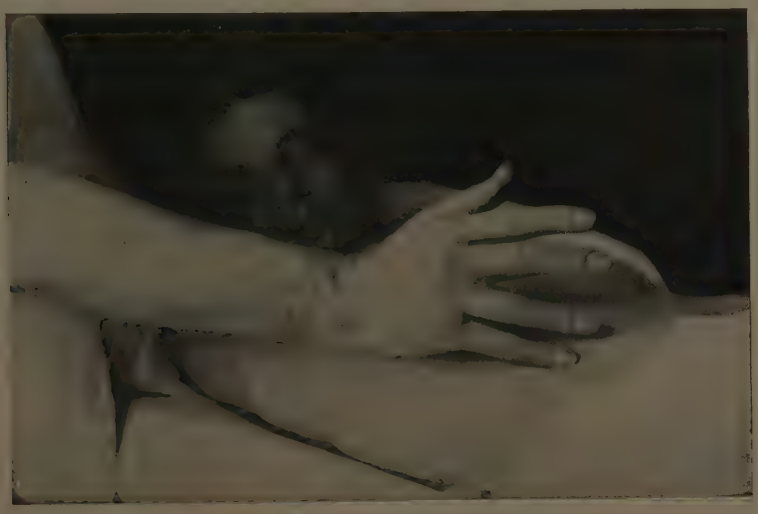


FIG. 278.—"PIANO PERCUSSION."

stroke and requires practice to make the fingers fall properly and in order, but it is of considerable value and will help to prevent an error in diagnosis.

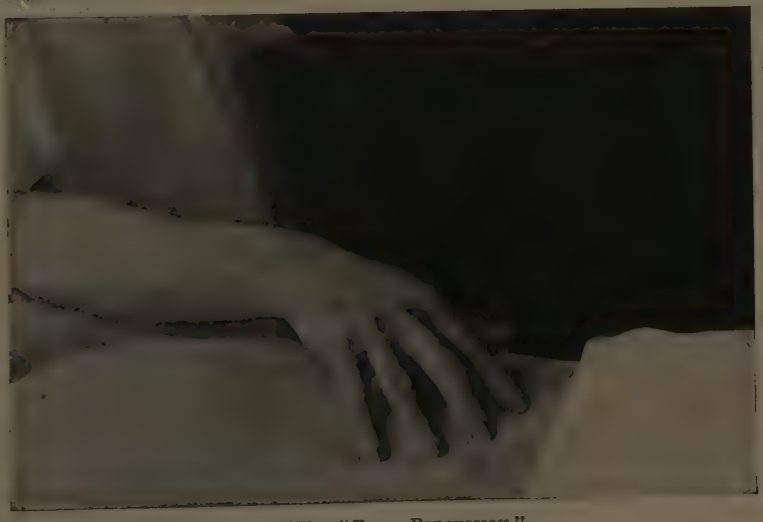


FIG. 279.—"PIANO PERCUSSION."

And, finally, attention is called to one other method. It is the most simple and should be used by every careful examiner: the simultaneous palpation of both iliac fossæ in cases of suspected acute appendical involvement. We have all noted in cases where there is acute

disease in the appendix that the affected side offers greater resistance to the examining hand. We palpate first the healthy side and then the other, and see quite a difference, especially in typic cases; but Murphy has pointed out and proved by clinical results during the past twenty years (since 1889) that decidedly more information is gained when both sides are palpated simultaneously. Compare the way in which the examiner's left hand sinks into the patient's iliac fossa to the lessened descent of his right hand on the side of the inflamed appendix. The difference is grossly apparent in the typic cases. So it is with the slightly involved appendices, those cases with slight recurring attacks, the atypic cases, that this test is most serviceable. An equal pressure on the two sides at the same time, "comparative bimanual examination," will show a difference which, with practice, is discernible in practically all cases where there exists an acute pathologic condition within or around the appendix.

The **symptoms of acute appendicitis** are as follows, and occur practically always in the same order:

(1) Pain, primarily in the epigastrium and later at the site of the appendix.

(2) Nausea or vomiting, usually coming on a few hours after the onset of pain and only repeating the attack a few times. It never precedes the pain.

(3) Local sensitiveness and muscular rigidity over the site of the appendix, showing markedly when contrasted with the opposite side.

(4) Elevation of temperature, coming on three to twenty hours after the onset of pain.

(5) Leukocytosis is present in about 97 per cent. of the cases. When absent, there may be a marked elevation of temperature.

Treatment.—Since 1907 Sonnenburg has been following the practice of Christian Fenger, of Chicago, from 1890–94—that of employing castor oil both for diagnostic and therapeutic purposes in appendicitis; his experience, however, has been somewhat different from that of Fenger, as the latter had such unfavorable results that he early abandoned it.

At the 1910 session of the German Surgical Congress Küttner stated that he had personally suffered from recurrent appendicitis for eleven years. There was a last attack in June, 1906, following which he took some castor oil; in one-half hour the pain increased and vomiting appeared, together with chills and fever. Sixteen hours after taking the oil operation was performed, and the appendix found gangrenous with progressive peritonitis. Consequently he does not hold this treatment in very high favor and thinks it should be abandoned.

If any further evidence were needed as to the value of early operation in appendicitis, it would be furnished by several series of statistics which have appeared recently. Up to the beginning of the year 1909 Schnitzler had operated on 2000 cases: 1063 interval operations, with a mortality of 0.47 per cent. (5 deaths), and 937 acute cases, with a mor-

tality of 10.5 per cent. (99 deaths). Of the acute cases, there were 444 operated on within the first forty-eight hours, and 152 on the first day furnished 7 deaths (4.6 per cent.), while of the 292 operations on the second day, there were 22 deaths.

All of the operations at the Presbyterian Hospital (New York) from 1906–09 have been analyzed by McWilliams; they fall into three classes: acute cases, 687; chronic and relapsing, 512; and removal of the organ in connection with other operations, 212. He points out that the mortality mounts after the first day. Thus 145 patients were operated on on the second day, with 9 deaths (6 per cent.). Peritoneal sepsis was the cause in 6 of these, 2 others died after operations for obstruction, while the last died of pneumonia. Of 103 patients operated on on the third day, 8 died (77 per cent.); the fourth day gave a death-rate of 18 per cent. (72 operations, 13 deaths); on the fifth and sixth days the operations were about equally fatal, each 14 per cent. Combining the operations done from the third to the sixth days inclusive, the mortality was 12.7 per cent.

Speaking at the 1910 meeting of the German Surgical Congress, Kümmel said that the diagnosis should be made within twenty-four hours if possible, so as to operate within the first forty-eight to fifty hours. He gave the following table of his early operations:

OPERATIONS IN FIRST FORTY-EIGHT HOURS.

Year.	Cases.	Operation in first twenty-four hours.	Recovery.	Deaths.	Per cent. mortality.
1903	5	0	5	0	0
1904	37	17	34	3	8.0
1905	53	23	49	4	7.5
1906	88	49	85	3	3.4
1907	84	61	84	0	0
1908	120	62	119	1	0.8
1909	143	89	142	1	0.6
1910	44	0	44	0	0
Total	574		562	12	2

Referring to the subject proper of his paper, "How to Prevent Abscesses and Peritonitis," he concludes that the ideal treatment is early operation, that is, within forty-eight to fifty hours. Early operation is the best means of avoiding serious consequences.

Technic.—There have been no marked improvements in the technic. A median incision is recommended by Reymond, after an experience in 47 cases, all recovering without postoperative hernia. He gives several reasons why this method is preferable: (1) If the common type of appendicitis is met with, operation by this route is as easy as by the usual incision; if, on the other hand, there is anything abnormal about the case, the lesions are much more accessible by the median route, and the secondary foci are incomparably so. (2) This incision enables one to reach lesions which may accompany the appendicitis or simulate it, for instance, affections of the adnexa. (3) It is better surgery, where an intraperitoneal infective focus has to be removed, first to open the

peritoneum and protect it before attacking the focus itself. Exception is made for the cases where the abscess is clearly localized, and the operation is to be limited to opening this collection. (4) If drainage is necessary, it may be carried out either through the original incision or through a stab-wound to one side.

In 1904, after moderate experience with transverse incisions in pelvic operations, it occurred to Rockey that such an incision would be more suitable in appendectomy than the oblique or vertical ones. After putting this into practice the method proved so satisfactory that, with few exceptions, he makes it now his routine method. It has several advantages: (1) The incision is parallel with the fibers of the deeper muscles, (2) it gives more direct access to the base of the appendix in proportion to its length, (3) it does not divide the motor nerves to the rectus, (4) its outer end is the most favorable place for a drain, (5) there is a minimum scar.

The typic incision, he tells us, begins at the outer border of the rectus and extends transversely out (usually not over $1\frac{1}{2}$ inches) toward a point slightly above the iliac spine. The external oblique aponeurosis under this line is thin, and may be cut through on a line with the skin incision. Moreover, the direction of the fibers of the internal oblique and transversalis being exactly transverse at this point, the incision may be carried through them and the peritoneum opened on the same line. The external oblique aponeurosis may be separated, and the incision finished by McBurney's method. This is not necessary, however, as the through-and-through suture of the combined aponeurosis and muscles will give sufficient strength to the wall. In abscess cases no attempt should be made to separate the fibers of the external oblique, but the incision should be made directly through all layers. If the incision needs to be enlarged, this can be done either by dividing the sheath of the rectus and retracting its fibers inward, or enlarging it outward by continuing the incision through all layers on the same line.

Hesselgrave also recommends transverse incisions. He divides the advantages into two classes: those for the operator and those for the patient.

The former comprise: (1) Easier and less tiresome operating, because of direct access to the field of operation and the better view. (2) Simpler, because one does not have to learn a variety of incisions running in various directions. All that is needed is to learn the anatomy of the cross-section of the abdomen above and below Douglas' fold and endeavor to keep the incision within the limits of the semilunar lines. (3) If more room is needed than originally thought, it can be had by increasing the incision in either direction.

From the patient's standpoint some of the more important advantages are: (1) Better looking scar. (2) Stronger union of the aponeuroses. (3) Less pain, especially when the recti are cut, due to absence of spasm of these muscles. (4) There is less wound reaction, since the margins are not contused by retractors and the skin is closed by a technic without needle or thread. (5) Less anesthetic is needed,

especially when the recti are cut, because there is no rigidity to overcome. (6) The intestines are afforded greater protection, since they are retained within the cavity surrounded by their normal envelope. (7) Less gauze packing is necessary and no pieces will be left overlooked, since they are all in sight.

In obscure and complicated cases, where there is evidence of advanced peritonitis, the abdomen should be opened through the rectus muscle ½ inch from the median line. This gives better access (1) to the appendix, (2) to the pelvic suppuration, and (3) admits of drainage of right and left pelvic fossæ. It may be necessary to make a long incision to give easy access to the appendix, but the other advantages more than compensate for this, or the transverse Pfannenstiel incision may be made and elongated as needed. This, however, has the disadvantage of failure of primary union, leaving a wide, gaping opening.

The method of management of the stump advocated by Knott is the following: The meso-appendix is ligated with No. 1 plain catgut. An incision is made between the ligatures and the appendix until the latter has been freed to its base. Around the base, practically flush with the cecum, a ligature of No. 2 silk is placed and tied tightly; a hemostat is then clamped on the appendix ½ inch distal to the silk ligature. After the tissues in the immediate neighborhood have been protected with gauze the appendix is divided midway between the ligature and the forceps, the stump thoroughly cauterized both inside and out with pure carbolic acid, and, after being thoroughly dried, the cecum is allowed to drop back into the abdomen.

Until a few years ago it was Knott's practice to cover the stump, wherever feasible, by carrying a fold of cecum over from each side, held in place by Lembert sutures. This was finally discarded as unnecessary after repeated observation of the fact that where, for some reason, this infolding was impossible, convalescence was just as smooth and rapid. Since the adoption of this technic some 800 patients have been treated, with no complications of any sort attributable to the stump.

Mopping the stump with formaldehyd solution of a strength of 16 per cent. is advocated by Miller. This would seem to possess several advantages over carbolic acid and alcohol, which are often used. It enhances mummification, destroys the mucosa, and, in addition, may tend to limit small hemorrhages when the stump is not ligated. Such a mummified stump is certainly a less favorable site for bacterial growth than the sloughing surface produced by the application of carbolic acid. This is especially true if the stump is not inverted or covered. There seems to be less liability to adhesions by this procedure.

Knott, in 2000 cases in which he used the silk ligature on the stump, has seen no postoperative hemorrhage.

Hessert, on the other hand, had 3 cases, one of them fatal. His technic comprised clamping at the base, cutting off the distal portion flush with the forceps, inserting a purse-string suture around the base, releasing the forceps, and inverting the stump while the suture is tied.

He points out that mere crushing of the stump is not a sure safeguard against bleeding, and believes that use of the cautery clamp is perhaps the best and safest method of dealing with the stump, since it effectually sterilizes the cut end and efficiently guards against bleeding. When he has not the requisite appliances at hand, however, he advises the following: The appendix is grasped at its base by a strong forceps and thoroughly crushed; this forces most of the mucosa up and down, so that the crushed portion is mostly reduced to fibrous and connective tissue. The forceps is then released and a catgut ligature tied around the crushed portion, after which the appendix is cut away. As a safeguard the distal portion may be grasped with a light pair of forceps before cutting, to guard against any escape of the contents. The stump contains little if any mucosa, being cut close to the ligature; it can be sterilized with carbolic acid if desired. The stump is then buried under a row of Lembert sutures, the method used by Murphy. Any method, he adds, though otherwise surgically correct, which does not absolutely provide against hemorrhage, is faulty.

Judd reported a case of hemorrhage after the use of the purse-string suture in a man of thirty-three. Although there was eventual recovery, the amount of blood lost in six days after operation amounted to 58 ounces in all, hemorrhages occurring on eight different occasions. Commenting on Judd's case, Wyeth observes he made diligent enquiries by correspondence and personally, especially at the 1907 meeting of the American Medical Association, and was unable to obtain the details of a single case of accident after the application of the silk ligature to the stump, no other procedure being resorted to. One of the cardinal principles of surgery is to secure the best possible result with the least possible violence to the tissues. In Wyeth's opinion this principle is violated by the unnecessary suturing of the cecal wall.

Having to deal with a very troublesome bleeding vessel in the wall of the stump close to the mesentery, Walker made use of a device practised by myself for the last twenty years—a modification of the circular purse-string into a figure-of-8. The object of the second loop primarily was to ligate the vessel in the wall, which, according to Hessert, is present in about 5 per cent. of the cases, but it is also to be used to roll in the mesentery, thereby covering in the triangular space otherwise left uncovered by peritoneum.

Before inserting this suture the artery in the outer aspect of the meso-appendix is tied as customary. Then the catgut suture is inserted, beginning at the base of the appendix on the side opposite the mesentery, and, passing well under the artery, is made to encircle it, grasping the meso-appendix on its way, finally coming out near its beginning. The stump is inverted by grasping part of it with a hemostat passed underneath an exposed part of the suture and depressing the handles, after which the purse-string is tied as usual, the forceps being loosened and carefully withdrawn. Thus the cecal opening is closed, all possible hemorrhage effectually controlled, and the triangular space covered by the inversion of the meso-appendix.

Additional evidence as to the merits of the doctrine of *Non nocere*, which I have advocated on numerous occasions, is furnished by the experience at Mt. Sinai Hospital, and set forth by Gerster. From May 1, 1899, to Dec. 1, 1908, 609 cases of free progressive peritonitis were admitted to the two surgical divisions, only 148 were due to other causes than appendicitis, thus leaving 461 due to this cause.

Their early efforts at the cure of diffuse peritonitis were dominated by the idea they were dealing with a process identical with, if not analogous to, phlegmon. Multiple and extensive incisions, the object of which was the exposure and evacuation of accumulation of seropus and pus, were the routine, supplemented by vigorous mopping and irrigation. Pursued with the utmost thoroughness, no hesitation was felt in carrying measures to the point of systematic eventration, the purpose being a merciless toilet of all the affected surfaces. Replacement of the distended intestines being very difficult, gas and liquid feces were evacuated by multiple enterostomies. Another practice almost universal at that time, but now abandoned, consisted in the use not only of abundant drainage by tubes, but also of massive gauze packs introduced into the various recesses of the peritoneum. These were removed either shortly after operation, causing intestinal prolapse, or, left in a long time, were, they thought, sometimes the cause of ileus. Thus were added to the exhaustion caused by the malady the depressing effects of prolonged anesthesia and of heroic surgery, resulting in a frightful mortality. If any patients survived they did so rather in spite of the therapy than in consequence of it. Thus there was a universal attitude of general discouragement.

Relief came from the growing conviction that the surgical elimination of the *causes* of peritonitis was the true way to combat the disease. Early they learned to recognize the conditions which produced peritonitis, and the earliest possible attack directed against appendicitis, the most common causative factor, became a measure which, against much opposition, has finally attained almost universal acceptance. The indications for operation, first timidly defined and surrounded by arbitrary and senseless particulars, became more and more stringent. The rule not to operate before the third, fourth, or fifth day after the onset was gradually abandoned, and prompt operations, done at any stage of the disorder, began to reveal all the phases of the process. Thus it became more and more evident that in peritonitis the stoppage of the leak, together with simple drainage of the infective focus, and in the more diffuse forms, with additional drainage of the most dependent, *i. e.*, the pelvic part of the peritoneum, aided by Fowler's posture (causing gravitation of exudate into the pelvis)—would yield better results than the excessively exhausting methods of former days.

In their treatment at present all measures are dominated by the following requirements: Early and rapid operation, stopping of intestinal leakage; peritoneal drainage aided by posture; maintenance of the strength by proctoclysis; withholding of food and drink while vomiting persists, with frequent gastric lavage; and, finally, the discreet

administration of opiates. By the use of the measures just enumerated the mortality fell from 79 per cent. in 1899 to 14 per cent. in 1908.

End-results of Appendectomy.—A few years ago Balloch concluded he would try to ascertain the results of removal of the appendix so far as they could be elicited from the patients themselves. The following classes were not questioned: Those in whom the organ had been removed during laparotomies for other conditions, acute cases, and hospital cases, the last owing to the difficulty of tracing them and the presumed unsatisfactory nature of their replies. This left the cases where appendectomy was performed for chronic or quiescent disease, and he selected 25 instances of this nature from his records. Each patient was intelligent, hence fully capable of estimating the results, whether good or bad. Many were interval cases, with no particular evidence of disease at the time of intervention. Questions were asked as follows: (1) What is the condition of your general health now, as compared with what it was before operation? (2) With respect to pain in the abdomen, digestive disturbance, bowel movements, etc., is your condition better or worse than it was before operation? (3) Has your body weight increased or diminished? (4) Are there any other results, good or bad, which you consider to be due to the operation?

Replies were received from 22 patients: (1) Eighteen answered that their general health had improved, 4 that they could notice no change; 1 was worse. (2) With reference to abdominal symptoms, 16 noted improvement; 5 could notice no change, while 1 patient reported she was worse, though giving no details. (3) Over one-half—13—reported a gain, in one case over 25 pounds within a year. No change was noted by 7, while the other 2 had lost weight, but attributed the loss to other causes, such as subsequent illness, etc. (4) None of the patients could attribute any bad results to the operation.

A similar inquiry was carried out by Jones in 87 cases from St. George's Hospital. Information was asked especially as to (1) the existence of pain, constipation, flatulence, etc., as being possibly caused by adhesions; (2) tenderness of the scar; and (3) ventral hernia. Of the 87 replies, 54 patients have been in perfectly normal health since their discharge; 27 replied that although their health had been good, symptoms arose from time to time which attracted their attention to the wound. Six patients thought they had definite grounds for the complaint of ill-health since the operation. Of this last class, 3 unquestionably have ventral hernia, 2 suffer from severe pain occasionally, while the other charges the operation with a result which it probably could not have produced, viz., rupture in both groins.

Stanton investigated the end-results in 100 cases of chronic appendicitis operated on by him. There were 64 cures and 36 failures. The majority of the latter (16) cases were in patients complaining of right inguinal pain associated with chronic constipation. At operation such patients presented an unusually long or dilated cecum, usually in company with other evidences of enteroptosis. Stanton thinks it possible that in the future a certain proportion of these patients may be

cured by an operation for fixing the cecum, such as that suggested by Wilms, but appendectomy alone does not cure. Unless the diagnosis is absolutely certain he also believes the gall-bladder, stomach, and right kidney should be explored, and the possibility of a Lane's kink excluded in all cases operated on for chronic appendicitis.

Writing along the same lines, Horsley tells us that for a year past he has been carefully examining the last few inches of the ileum and the valve in every case of chronic appendicitis, and in every abdominal operation as well, where the patient's condition justified it. He, in common with many other operators, had been content to remove the appendix through a small incision and deliver no more of the bowel than possible, this often consisting only of the appendix. In a considerable portion of his cases of chronic appendicitis there has been a long persistence of the same symptoms complained of before the appendectomy. Occasionally these symptoms have been so definite and persistent that it is untenable to attribute them to adhesions.

In many of the chronic cases the Lane kink and other pathologic conditions can be definitely excluded, yet, after removal of the appendix, precisely the same symptoms are complained of. The ileocecal fold (described under Anatomy) is believed by Horsley to be responsible for this small, but annoying group of cases. On account of its attachment a chronic appendicitis may produce a shortening of this fold in such a manner as intestinal stasis produces shortening of the band which gives rise to the Lane kink. If this fold is not removed when the appendix is removed the whole condition is not corrected. Hence he recommends that the fold be removed in every case of chronic appendicitis. When it has been previously shortened for stasis and appendicitis it will produce symptoms whether the appendix itself be removed or not. After appendectomy this fold, which normally may not exert undue traction on the ileum, is likely to be so constricted by the ligature on the mesoappendix that it will produce undue pulling on the ileum, with, as a consequence, kinking or partial obstruction where there was none before. Of course, adds Horsley, there is no occasion to remove a normal ileocecal fold unless the appendix must be removed also.

Recently, therefore, he has been removing this fold when at all well developed, cutting it close to its insertion into the ileum, then tying the vessels with fine catgut. Sometimes the peritoneum must also be approximated with a fine suture. While it is too early to report *definitely* on these cases, he has been impressed by the fact that there has been much less complaint of postoperative symptoms since this procedure has been adopted.

König also considers the complaints of the patient after removal of the appendix. There are several reasons for these, coexisting cholelithiasis, for instance, as well as enteroptosis or disorders of the female genitalia. König believes by far the most important factor is the formation of adhesions, hence a great deal can be done to avoid this cause. He cites 71 cases to show that adhesions are especially liable to develop when there are pre-existing adhesions or when the peritoneal

covering is injured in any way. Moreover, he asserts that if adhesions are already present, the outcome of the removal of the appendix is doubtful, the operation merely increases the tendency to formation of adhesions, and the more extensive these are the more liability there is to future trouble.

For this reason König is in favor of early operation before adhesions have formed; he does not believe in "interval" operations. As regards technic, the organ must be removed through the smallest incision possible, and all possible means used to prevent the formation of adhesions. These consist of starting peristalsis and early exercise, first moving the limbs about in bed, getting up early, and keeping up gymnastics at home, with regulation of the bowels. When adhesions are found to be already present, in addition oil should be given both *per os* and by enema, with gentle massage of the abdomen, beginning a week after operation, and first avoiding the site of operation, but later covering the whole abdomen. If at the time of operation adhesions are found to be extensive, the patient is instructed to lie on the other side for several hours the next day, to change his position in bed often, even assuming the knee-chest position at times; lastly, to get out of bed as early as possible.

Classification.—Before leaving appendicitis the classification proposed by MacCarty may be referred to. He makes four groups, as follows:

(1) **Appendicitis Catarrhalis Acuta.**—A condition in which the mucosa is infiltrated with leukocytes and is congested; there is a reaction in the lymph-follicles and tissue of the submucosa. The lymph-spaces or vessels in all the other coats may also contain leukocytes.

(2) **Appendicitis Catarrhalis Chronica.**—Arises as a result of repeated mild and severe acute catarrhal conditions, and is marked by an increase of scar-tissue and distortion of the normal regularity of the coats and the glands. Blood-pigment is frequently present in the mucosa.

(3) **Appendicitis Purulenta Necrotica.**—An advanced stage of the acute catarrhal condition plus the formation of intramural abscesses and necrosis.

(4) **Peri-appendicitis Acuta.**—Merely describes an extension of the conditions just described to the peritoneum. The subserosa and serosa become congested, purulent, or necrotic. The scar-tissue remains of such a condition may be described as *peri-appendicitis chronica.*

The fifth group consists of obliteration.

Intestinal Obstruction Due to Appendicitis.—Lenormant has recently reviewed this subject founded on his own experience and on late papers of Rotter and Ruge (from Körte's clinic). There are two well-marked varieties of this condition: paralytic obstruction, allied to the intestinal obstruction which always accompanies circumscribed or diffuse peritonitis, early or late; the other type is the mechanical occlusion with some material obstacle to the circulation in the bowel. As regards the former group, obstruction of appendicular origin is really

very frequent; and even if we exclude the intestinal paralysis accompanying the peritonitides, appendicitis is still one of the most important factors of obstruction, and Ruge remarks that together with annexitis it is the chief cause of bands and peritoneal adhesions producing ileus.

Rotter alludes to 22 personal cases. Körte in twenty years (1890–1910) met with 44 cases; during this period he had a total of 168 cases of obstruction of the intestines. During the same time he had 2385 cases of appendicitis, hence the frequency of obstruction was a little less than 2 per cent. Lenormant himself, in 30 instances of obstruction due to various causes, found 2 following appendicitis.

From a practical standpoint a distinction must be drawn between early obstruction contemporaneous with the acute crisis, and late obstruction coming on more or less remotely in a patient with quiescent appendicitis, or in cases where the organ has been removed.

Early obstructions make up about one-half of the cases met with. Paralytic obstruction is the form most frequently encountered during the acute crisis. While rare in simple appendicitis, where the intestinal paralysis (nearly always incomplete and limited to the ileocecal segment) does not ordinarily merit the name of obstruction, it is, on the contrary, relatively frequent where the appendicitis is complicated by extensive peritonitis. It is merely an instance of the paralytic obstruction common to all the peritonitides, and generally looked on as of toxic or reflex origin. Very often, especially in cases of appendical peritonitis, these occlusions are not adynamic; in addition to the intestinal paralysis there is a mechanical factor which cannot be neglected; adhesions are already present in recent foci and kinks of the bowel are not rare. Rotter insists on this phase. He has seen 7 cases of so-called paralytic occlusion in the course of the crisis or after operation for appendical peritonitis, and in all these cases found the bowel indurated and kinked. In some cases the kink was situated at the junction of a segment still paralyzed, at which point the lumen became contracted without adhesions; in other cases it was caused by and kept in place by an adhesion near the termination of the ileum and in contact with the drain through Douglas' space.

There are also early occlusions coming on in the acute phase of the appendical crisis in which the rôle of the intestinal paralysis is *nil* or at least quite secondary, and which are primarily mechanical obstructions. The circumscribed peritonitis which limits the focus is accompanied by the formation of multiple adhesions, and by more or less extensive agglutination of the coils of the small bowel; kinking is sufficient enough in some cases to bring on complete obstruction.

Such obstructions from adhesions in contact with the appendical abscesses are not very unusual. Körte observed 6 among 20 cases of early occlusions in connection with appendicitis. Rotter records 6, most of them incomplete; in 2 cases it was necessary to free the adhesions by surgical measures. All his patients recovered. Lenormant believes this is the most frequent origin of ileus during the stage of

abscess, or (as the Germans term it) the "intermediate stage." Here, as in cases of paralytic obstruction, they may be attributed after operation to the action of the drain or tampons. The differential diagnosis of these cases is rather delicate. The recurrence of the abdominal symptoms is often attributed to the formation of a new focus or to diffusion of the peritonitis. The reappearance of the intestinal paralysis which had ceased with the evacuation of the abscess, and especially the existence of peristaltic contractions visible through the abdominal wall, indicate obstruction. Ruge emphasizes the value of the last symptom, and it enabled Lenormant to make a diagnosis in one of his cases.

Late obstructions comprise 24 of the 44 cases in Körte's series, and 9 of the 22 in that of Rotter. The date of their appearance is extremely variable, Rotter has seen them two and four weeks respectively after the end of the crisis. Generally, however, the interval extends to months or even years; for example, in one of Körte's patients the obstruction originated from an appendical inflammation twenty-five years previous. It will readily be seen that when the initial appendicitis occurred some years before or when it was slight the etiology might be easily overlooked. Thus in over one-half of Körte's patients the history gave no clue, and the operation alone disclosed the influence of the appendix.

This variety is observed, no matter what the treatment of the appendicitis has been, in cases operated on as well as those not subjected to intervention; and in operations in the acute stage as well as in interval operations. In Körte's statistics of 17 cases, 9 had been treated medicinally, 4 had been operated on in the acute stage, 2 during the interval, and 2 during peritonitis. Early operations within the first forty-eight hours do not figure in the series, and Ruge believes that in preventing abscesses and adhesions one has the only means of preventing danger in the future. Lenormant alludes to several cases placed on record by Federmann in which occlusion followed early interventions.

The obstruction in this group is always of the mechanical type, though the exact nature varies. The most common variety is occlusion by bands. The band compressing the bowel is most often a sequence of peritonitis, in other cases an omental adhesion, in still others the appendix itself is adherent at its tip. Ruge points out the relative frequency and grave nature of the strangulation by the adherent appendix; in 6 cases of Körte's there were 4 deaths. He attributes this gravity to the infection through the lumen of the appendix after section of the band, and also to the fact that the organ is often gangrenous at the time of operation from arrest of circulation. Moreover, in this variety the dangerous elements develop acutely, and gangrene of the strangulated intestine is frequent (eight times in 18 cases) and early, coming on in seventeen hours in 1 case. The danger is still further increased by the fact that the bands may be multiple, and some may be overlooked at time of operation. Körte, in one of his cases, discovered a band and divided it; the symptoms continued, however, and at a necropsy a second one was found.

Adhesions and kinks of the bowel seem to cause occlusion less frequently. In some instances there is a single limited kink, in others a conglomeration of adherent coils. The latter are evidently more grave, and freeing the bowel may be impossible or necessitate intestinal resection; Rotter met with 2 such cases, both of them ending fatally. (Intestinal exclusion, however, is a much better procedure in extensive agglutinations.) In the obstruction by kinking the evolution is often less rapid than in those from bands; the stoppage of the fecal circulation in the bowel may be incomplete in the beginning. In such cases we see a succession of crises of increasing gravity.

So much for the two most common anatomic types of postappendicitis obstructions. There are, however, other (more exceptional) forms. Sprengel and others have described examples of volvulus about an adhesion, and Lenormant alludes to a case where the torsion of the bowel accompanied a kink due to adhesions. This occurred in a girl of twelve who had been operated on for appendicitis during the acute stage two years previously. The symptoms were of three days' standing, and had commenced with colic, soon followed by vomiting. The syndrome of occlusion was well-marked—meteorism, fecaloid vomiting, arrest of feces and flatus. At the operation he found two loops of small bowel adherent to the cicatrix of the old operation, kinked at an acute angle and tense like cords, around one of these cords the terminal portion of the ileum had been rolled. The adhesions were loosened, the bowel untwisted, and replaced. Circulation in the bowel was re-established almost immediately, and the patient recovered without incident.

Körte encountered 2 examples of still rarer varieties of obstruction following appendicitis. In one of them the bowel was compressed by an inflammatory swelling, the appendix was completely obliterated; near by, though outside of the lumen, were two fecal concretions forming the center of an inflammatory mass which kinked and compressed two coils at the same time. In the other case, which, like the first, was due to an old appendicitis and healed spontaneously, there was an occlusion from cicatricial stenosis in the ileocecal region. No trace of the appendix could be found at the operation. An indurated cicatricial deposit surrounded the bowel, there was a narrow stricture at the ileocecal junction, with ulceration in the cecum. Microscopic examination showed this was neither tuberculosis, syphilis, nor cancer.

In the case shown in the colored plate (Plate VI.) the condition resulted from an adhesion around the appendix fixing the omentum. The rotation then took place between the base of the omentum and this adhesion, producing the appearance shown, a central rotation with the turns on each side of the center in the opposite direction.

The patient was admitted to the hospital with a large tumor on the left side. The symptoms appeared suddenly after a proctoscopic examination, and it was feared the bowel had been injured by the physician making this examination, as the major portion of the tumor rested on the descending portion of the colon, just above the brim of the pelvis. Exploratory operation revealed complete torsion of the omentum.

Eventual recovery, notwithstanding pneumococcus infection of the wound.

A very grave prognosis attends these obstructions following appendicitis, statistics showing a mortality of about 50 per cent. (Körte, 44 cases with 21 deaths; Rotter, 22 cases with 11 deaths.) There seems to be no difference in the mortality between the early and late forms, 33 cases of early obstruction with 17 deaths, and 33 of late obstruction with 15 deaths. Lenormant, however, points out that in the group of early obstructions there are a goodly number of cases of diffuse peritonitis, the gravity of which is well known, even when not complicated with ileus (but now reduced to a minimum by the Murphy method of treatment). The cause of death in the 21 cases of Körte were as follows: Peritonitis, 13; collapse, 5; myocarditis, pneumonia inanition following enterostomy of the small bowel, 1 each.

The true treatment of these accidents according to Ruge should be prophylactic, *early operation on all cases of appendicitis, i. e.,* within the first twenty-four hours. The number of cases operated on in the first forty-eight hours is still quite small, and Lenormant fears that surgeons will continue to encounter these obstructions for a long time to come, unless the conscience of the medical profession is aroused by some extraordinary means to the sense of their responsibility for these crimes of procrastination—called " conservatism."

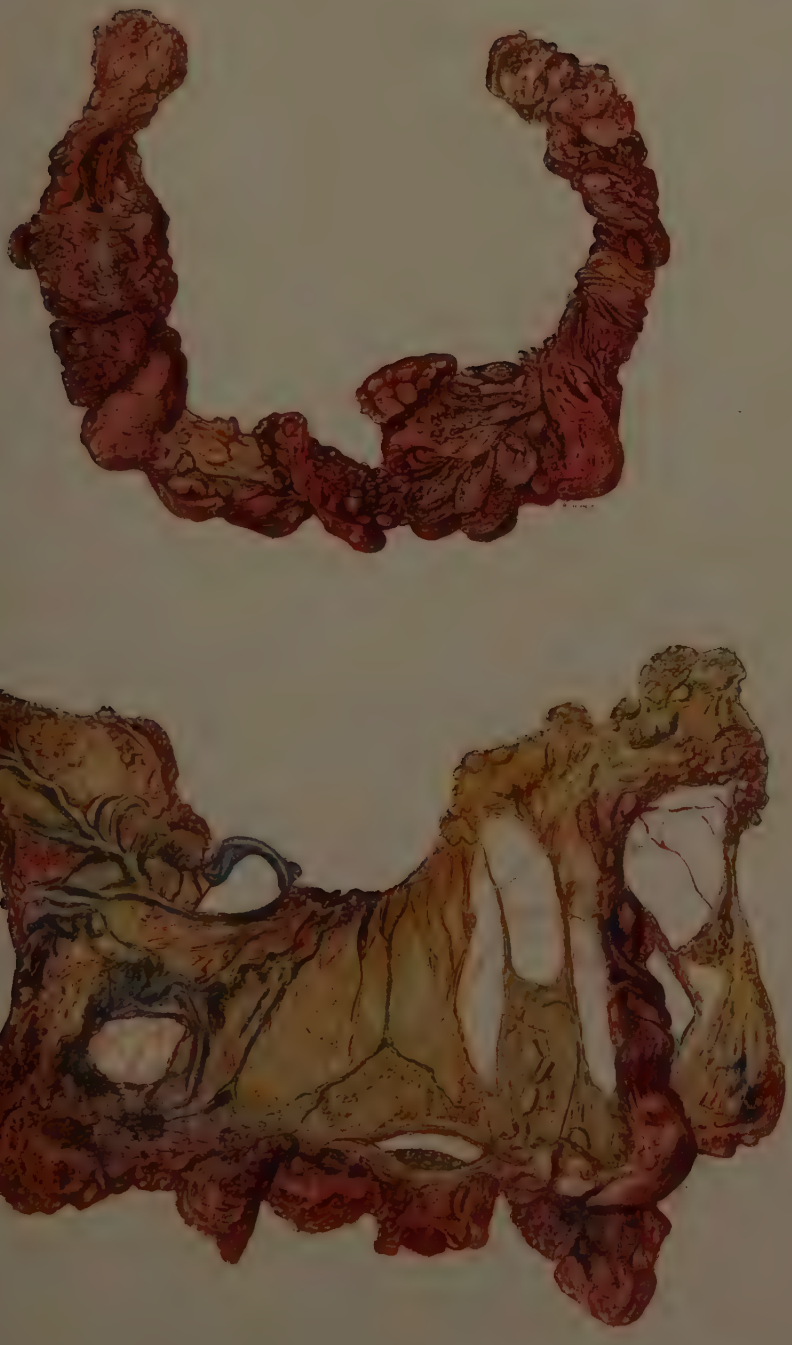
Immediate intervention here, as in all varieties of obstruction, no matter what the cause, is the only means of reducing the mortality. In early paralytic occlusion enterostomy is indicated: this was performed by Körte 10 times, with 5 successes. Lenormant believes it is preferable to multiple punctures of the bowel, though both Körte and Rotter have obtained cures by the latter procedure.

Enterostomy is not without danger, as it must be done on the small intestine, and one of Körte's patients died in a week from cachexia and inanition. For this reason Ruge asks if it would not be better to do a simple enterotomy and after emptying the intestine, suture it again.

In all cases enterostomy is contraindicated where we have to deal with mechanical occlusion caused by bands or adhesions, whether it be early or late. The indication is to remove the obstacle, dividing the band or freeing the adherent and kinked intestine. While this liberation may be very difficult in those complex cases where there is a congeries of multiple adhesions, it is none the less indispensable. Gangrene of the bowel, which (as has been pointed out) is not rare, necessarily calls for immediate resection. Körte carried this out in 8 cases, with 5 recoveries. In cases of this nature enterostomy may serve merely as a complementary procedure, assuring rapid evacuation of the toxic contents after removal of the obstruction; the opening is then made through the cecum, and in one of Lenormant's cases contributed materially to the successful outcome.

Subphrenic Abscesses Due to Appendicitis.—A few years ago Piquand showed the importance of appendicitis as a causative factor in the production of subphrenic abscess. In a series of 890 collected

PLATE VI.



Complete Torsion of the Appendix Due to Adhesion from Old Appendicitis.
(Author's Case.)

cases it was responsible for 191, coming second only to gastric diseases (251 cases). Ross reviews 31 personal cases. In 3391 consecutive cases of acute appendicitis at the German Hospital (Philadelphia) there were 30 with this complication (0.8 per cent.). While in 500 consecutive cases at a children's hospital there was 1 case (0.2 per cent.). Treves met with it in about the same proportion—a total of 6 cases in 1000 of acute appendicitis.

The mode of its production varies. The most frequent would seem to be from direct extension upward from the lower peritoneal fossa. Other routes are *via* the portal vein (rare); by lymphatic extension (*a*) up the retroperitoneal tissue on the right side, or (*b*) following the lymphatics around the deep epigastric to the falciform ligament; also as part of the general peritonitis.

Ross quotes with approval the explanation of the extension of the pus given by Barnard. The latter author points out that when a patient is lying flat on his back the posterior end of the subphrenic spaces are dependent and separated from the bed by not much over $\frac{1}{2}$ inch of tissue, made up of the skin, ribs, and diaphragm.

In the female, Douglas' pouch, and in the male the retrovesical pouch are likewise separated only by the skin, coccyx, and the flattened rectum. Dividing these dependent pouches are the elevations made up of the thick lumbar muscles, the iliac vessels, the kidneys, and the perirenal fat. When there is a profuse flow of serum such as accompanies general peritonitis, the fluid gravitates down into the pelvic pouch and up into the subphrenic spaces.

The purulent focus may be retro- or intraperitoneal. The former is much rarer; it was found in but 151 of the 890 cases collected by Piquand, resulting from various causes. The etiology in these 151 examples was appendical or perinephritic. The author last named divides the intraperitoneal variety according to the way they are shut off by the coronary ligament into anterosuperior (right and left) and postero-inferior (right and left). Ross groups them as right or left, anterior or posterior. He adds that it is often impossible to determine whether the abscess is intra- or extraperitoneal in origin.

Of the 12 cases reported by Barnard and 31 by Ross, 41 were on the right side, 1 on the left, and 1 on both sides. These figures, in Ross' opinion, tend to show that in most cases the extension to a subphrenic fossa from a diseased appendix is not from an accompanying pelvic peritonitis, but arises directly from the original appendical focus.

From a chronologic standpoint the cases may be divided into three groups: (1) Those found at operation; (2) those coming on late, or postoperative sequelæ; (3) those occurring a long time after the original infection. There is not a great difference between the first two classes as regards frequency, 20 and 17 cases respectively out of 40. The late type, however, is quite uncommon, only 3 out of the total 40 cases.

The symptoms being obscure as the affection complicates the original disease, both in the variety under consideration and in those due to other causes, its detection is not easy. From a symptomatic standpoint

the cases may be grouped under three heads: (1) Those presenting symptoms referred to the abdomen, antero-inferior collections; (2) Those with thoracic symptoms due to pushing up the diaphragm, superior foci; (3) Abscesses with lumbar signs, retroperitoneal foci.

Septic symptoms following an operation for appendicitis without evidence of their cause (the primary incision having progressed smoothly) are more commonly due to perinephric abscess than to any other cause. Next in importance are the signs of involvement of the base of the lungs, commonly indicated by a patch of dulness. In addition there are often the other indications associated with a pleural collection—*e. g.*, lessened breath sounds and fremitus. Notwithstanding the proximity of the purulent focus to the pleura, empyema is not very common. Of 21 necropsies, only 6 revealed purulent pleurisy and 1 non-purulent pleurisy; yet two of the former 5 cases showed actual perforation of the diaphragm.

When abdominal symptoms are present they are the same as those of any other intra-abdominal collection—pain, sensitiveness, and tumefaction. The latter is not very common, owing to the frequent location of the abscess deep under the liver or between this viscus and the diaphragm. In this latter class there may be some slight bulging and fixation of the thorax on the diseased side. Pain is most commonly of the localized pleuritic type. Tenderness is elicited only on deep percussion or palpation, especially the "fist percussion" of Murphy. The advantages of exploratory puncture with a long, fine needle are not availed of at all, or are postponed until the patient is in a moribund state from sepsis. In obscure cases doctors do not go to work in an energetic way as frequently and systematically as they should.

In the late cases the onset may be delayed from eight to as many as eighteen months after the primary appendicitis.

The prognosis is grave. The mortality of non-operated cases is 92 per cent.; even after later intervention the average mortality is 30 per cent. This is due to the delay in making a differential diagnosis of the true etiology of the infection symptoms, which are always very pronounced.

The routes of attack followed were three in number: (1) Through the abdomen for foci situated low down (214 of the 890 cases with 79 deaths, 36 per cent.); (2) lumbar, 47 cases with 11 deaths (23 per cent.); (3) transpleurodiaphragmatic, 210 cases with a mortality of 33 per cent. (68 deaths). This should always be a two-sitting operation, except when the diaphragmatic and parietal pleura are found adherent.

The general principles to be considered at the primary operation are: First, when there is a localized collection it must be explored as to its extent and by the least hazardous route of attack; second, the drainage must be efficient; third, if pus is present in the pelvis also, this cavity must be separately drained; fourth, drainage-tubes must be of sufficient caliber and rigidity to insure the evacuation of all infectious fluids.

Where there is diffuse peritonitis the patient must be placed in the

Fowler position; proctoclysis, after the method introduced by Murphy, should be instituted at once, and if the patient is greatly depressed an immediate intravenous saline injection of 1½ to 3 pints should be given, using all of the precautions so imperatively demanded for the success of this procedure. Streptolytic serum (20 c.c.) should be injected subcutaneously and autogenous vaccines at once prepared.

Hepatic Abscess Due to Appendicitis.—This is a rare complication and usually not discovered until the necropsy. The abscesses are usually multiple. Hepatic abscess, associated with or following appendicitis, arises through three routes: (*a*) Most commonly through the portal vein and associated with a pylephlebitis; (*b*) through the lymphatics from the surface of the liver; and (*c*) through continuity of destruction from parahepatic abscesses. Pylephlebitis is a much more common sequence of appendicitis than is generally believed. Its diagnosis as a fatal factor is usually overlooked. It is associated with recurring chills, high temperature, delirium, intense sepsis with a low leukocyte count, a mild icterus or occasionally intense jaundice, great sensitiveness to deep fist percussion over the spleen and liver, and deep palpation over the epigastrium. It can begin within a few hours of the onset of appendicitis or at any later period of the suppuration. It always terminates fatally. The necropsy reveals multiple abscesses in the portal vein with infarction and multiple foci of suppuration in the liver and spleen, and occasionally infarcts and thromboses in the systemic circulation.

Abscesses of the liver have a more favorable termination. Two cases under the care of L. A. Bidwell were diagnosed and operated on; one recovered. The abscess in both cases was single.

Hepatic abscess is usually a late complication, generally some weeks after the primary appendicitis; both of Bidwell's cases were apparently convalescent, having had normal temperatures for the first fortnight. In one of the cases the hepatic abscess followed the opening of a thoroughly localized appendical abscess about three weeks after the initial attack, accentuating one of the dangers of delay in these cases; in the second case intervention was necessitated by localized peritonitis due to perforation of the appendix. The pus in these cases does not have the characteristic odor of that of an appendical abscess. It is practically impossible to differentiate between hepatic and subphrenic abscess, and surgically it is of not much importance, since both should be operated upon; bulging of the right chest wall with increase in the width of the intercostal spaces rather than pushing down of the liver as a whole would suggest the former. Jaundice, or at least an icteric tinge of the conjunctivæ, is erroneously considered a constant sign of hepatic abscess following appendicitis. It was not present in either of Bidwell's cases.

All preparations must be made for an immediate complete operation as soon as the presence of pus has been elicited by the exploring needle, since there is danger of the pus escaping into the pleura or peritoneum upon its withdrawal. In most cases the purulent collection will be

reached by an incision similar to the one for subphrenic abscess, over the ninth rib behind the anterior axillary line. Portions of this rib and the tenth are resected and the diaphragm exposed. Unless adhesions are present the diaphragm should be sutured to the parietal pleura and the wound packed with nosophen or iodoform gauze to stimulate adhesions. The secondary opening of the abscess should be postponed forty-eight to seventy-two hours, depending upon the urgency of the symptoms. In the second operation, after dividing the diaphragm, the posterior surface of the liver is exposed; if adhesions are not present gauze is packed between the liver and the diaphragm. The needle is then inserted in the direction in which the pus was previously found. When the pus is located, a director is passed down by the side of the needle and the latter withdrawn. A pair of sinus forceps is inserted into the cavity along the groove of the director and its blades spread to blaze a track through the hepatic tissue for the insertion of the drainage-

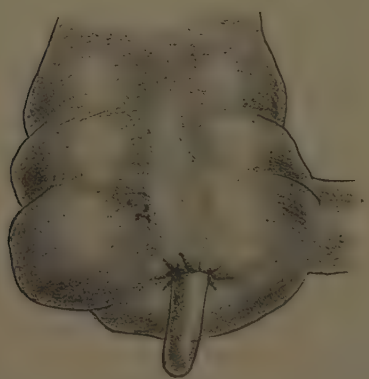


FIG. 280.—"PARTIAL" INTUSSUSCEPTION OF THE APPENDIX. (Moschowitz.)

FIG. 281.—SAME: LONGITUDINAL SECTION SHOWING SIX LAYERS OF INTESTINAL WALL. (Moschowitz.)

tube, which is secured to the skin by a suture, the rest of the wound being closed. Irrigation has no advantage and adds to the danger.

Acute Volvulus of the Appendix.—White reports a case of this unusual condition. A little boy of five, previously well, on September 4th received a blow on the abdomen. For a day there was little complaint, but on the morning of the 6th he complained of pain and tenderness in the region of the appendix, with rigidity of the abdominal wall; temperature, 99.8° F.; pulse, 100. He was sent to a hospital and operated on that afternoon. The appendix was not perforated, but was lying behind the cecum, greatly swollen, dark, and covered with flakes of lymph. On bringing it up it was found to have made two complete turns on its long axis. The meso-appendix extended as far as the junction of the basal and middle thirds and the torsion was limited to the end next the cecum. It was readily untwisted; it was

gangrenous and was removed; recovery. Rotation to the production of fecal and venous stasis is a much more common cause of appendicitis than is generally believed.

Intussusception of the Appendix.—This condition is rather uncommon. For example, Moschowitz gives the details of a personal case which he states was the first occurring in 5000 cases of appendicitis at Mt. Sinai Hospital during the past eleven years. However, two recent cases are not included in his series, and 4 cases have been published since his paper in the first half of 1911.

There are three types of intussusception: (1) The process may start at Gerlach's valve, more and more of the organ becoming inverted, and ceases when the swelling of the coats of the organ or adhesions of the apposed serous surfaces prevent its continuation (Figs. 280, 281). This type is called by Moschowitz a "partial" intussusception. As a rule, more or less of the appendix protrudes from the cecum, and a longitudinal section through the cecum and intussuscepted

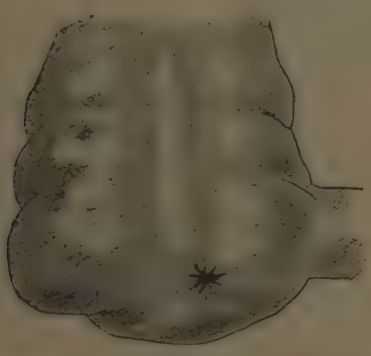


FIG. 282.—"TOTAL" INTUSSUSCEPTION OF THE APPENDIX. (Moschowitz.)

FIG. 283.—SAME: LONGITUDINAL SECTION SHOWING FOUR LAYERS OF INTESTINAL WALL. (Moschowitz.)

portion will divide the coats of the bowel six times. Eight cases of this type have been recorded. The process may not go any further, or it may proceed to (2) "total" intussusception (Figs. 282, 283). Here the whole of the appendix becomes inverted like the finger of a glove; by following up the colonic teniæ the base will be readily located. Section shows only four layers of bowel instead of six, as in the last type. The frequency is about the same—7 cases. (3) The inverted appendix acts as a foreign body, and more and more of the bowel is drawn in by the efforts at expulsion, finally resulting in ileocolic intussusception; most of the cases (16) belong to this group (Figs. 284, 285).

As regards symptoms, the diagnosis is based on those commonly present in intestinal intussusception. Appendical intussusception cannot be differentiated from the latter preceding operation. Further the differentiation has no practical significance. Blood in the stools in gross amounts is more commonly absent in the purely appendical invaginations.

Tuberculosis of the Appendix.—Primary tuberculosis of the appendix is believed to be excessively rare and is not in consonance with careful clinical observation. The ileocecal region is a frequent seat

FIG. 284.—INTUSSUSCEPTION OF APPENDIX: SPECIMEN AS REMOVED. (Wallace.)
A, Opening into base of appendix; *B*, inverted cecum invaginating appendix.

of the disease from which the base of the appendix is involved. Pulmonary foci may lead to secondary deposits in the intestine, and often the appendix is the only portion of the bowel affected.

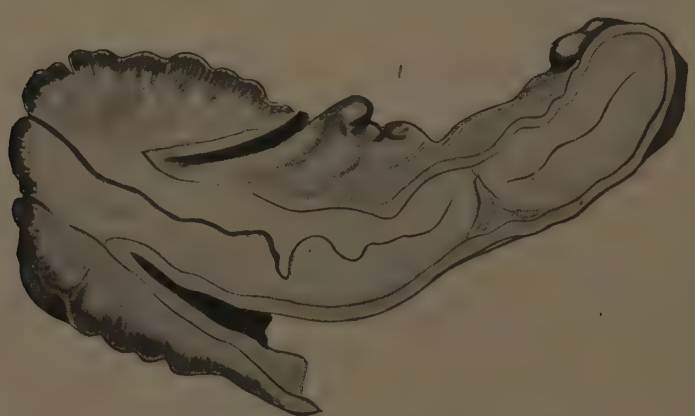


FIG. 285.—SAME: SPECIMEN BISECTED.

In 2000 necropsies at the Brompton Hospital for Consumption and Diseases of the Chest, Fenwick and Dodwell found in 17 that the appendix was the only area of the bowel showing evidence of tuberculous disease. White, in 263 necropsies at the Phipps Tuberculosis Institute,

found in 56 cases in which a microscopic examination was made that 33 (59 per cent.) showed tuberculous lesions.

Letulle states that in necropsies he has never found tuberculosis of the appendix without other lesions of the same nature in some other portion of the body. On the other hand, in 144 cases of tuberculosis of the appendix found at necropsy, the other portions of the bowel were healthy in all but 12. Alglave, in 52 specimens of ileocecal tuberculosis, discovered the appendix involved in 12, but in 11 of these there was tuberculosis either of the ileum, of the cecum, or of both. In 3055 operations for appendicitis from various sources, 50, or 1.6 per cent., were found tuberculous (Müller).

Tuberculosis of the appendix is somewhat more common in males (about 60 per cent.) than in females (40 per cent.). The age incidence in 64 cases collected by Müller was: two to nine years, 3 cases; ten to nineteen years, 18 cases; twenty to twenty-nine years, 21 cases; thirty to thirty-nine years, 16 cases; forty to forty-seven years, 6 cases.

Three forms are met with—the miliary, the ulcerative or caseous, and the hyperplastic. Tuberculosis is sometimes found associated with the acute type of appendicitis.

From a symptomatic standpoint, cases of tuberculosis of the appendix are divided into three categories by Alglave: (1) Tuberculosis of the appendix, whether isolated or complicating ordinary appendicitis, often remains latent. (2) It gives rise to crises of appendicitis. (3) It may manifest itself only by formation of an abscess in the iliac fossa with consecutive fistula.

Lejars attaches considerable importance to ballooning and tension of the abdomen, persisting after the subsidence of the attack; also to ascites. The latter, he states, no matter how small in amount, if its presence can be elicited and if it persists, should arouse a suspicion of tuberculosis when accompanying the ordinary symptoms of chronic appendicitis.

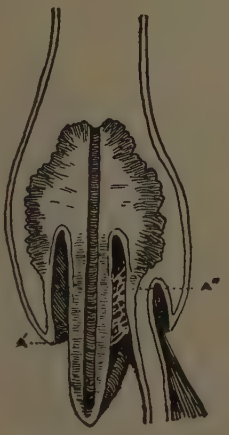


FIG. 286.—SAME: INTUSSUSCEPTION REDUCED AS FAR AS CECUM, SHOWING APPENDIX INVERTED AND INVAGINATED.

Appendix as shown in Figures 284 and 285 is removed at A′–A″.

The operative mortalities are not large; but the end-results are not very encouraging. The results in the 65 cases collected by Müller were as follows: Died from operation, 1; died later (three weeks to six months), 3; died still later (from one to three years), 3. Alive and well (from one to three years), 8; alive and well (from one to seven months), 8; alive and well (time not stated), but still tuberculous, 10.

In 78 cases collected by Alglave there were 56 operative cures; 4 died shortly after operation, and there were 22 postoperative fistulæ.

The operative treatment depends on the state of the lungs. Müller advises that intervention be always undertaken if the pulmonary lesions are not too extensive. As regards technic, ether must not be

used on account of the irritating effects on the lungs. Spinal or local analgesia answers the purpose admirably. It is often advisable to excise the ileocecal segment as well as the appendix. Open the intestine close to the tuberculous lesion, as failure of union frequently occurs in this class of cases and leads to a fatal result or permanent fistula. Of 10 patients, 7 died, 2 still persisted. Cecal exclusion by anastomosis of the divided ileum to the ascending or transverse colon or sigmoid gives the best results in this class of cases.

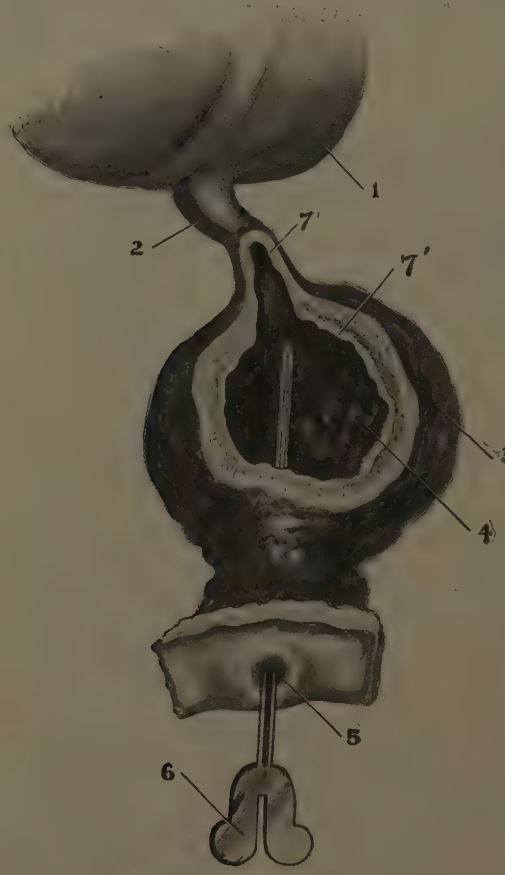


FIG. 287.—HYPERTROPHIC TUBERCULOSIS OF THE APPENDIX. (One-third natural size.) (Gayet.)

1, Cecum; 2, pedicle formed by the healthy portion of the appendix; 3, hypertrophied portion; 4, mucosa; 5, cutaneous orifice of the fistula; 6, director passing through the fistulous track into the lumen of the appendix; 7, mucosa of the appendix becoming continuous with 7', the wall of the cavity.

Hyperplastic or hypertrophic tuberculosis of the appendix is rare. It manifests the same characteristics as the hypertrophic form affecting other segments of the bowel, notably the cecum. Gayet has recently given the details of an operation in this variety on a woman of thirty-eight. Two years previous she had a crisis of appendicitis; at that time a large abscess was opened, but the appendix was not located. A year later there was fistula formation with free escape of pus; at this time he operated. Making an elliptic incision about the fistulous opening, he came upon a mass the size of a mandarin orange, everywhere adherent. After a great deal of trouble this mass was freed and found to be attached by a pedicle to the cecum, which proved to be the base of the appendix, nearly 1.5 inches long and apparently healthy. The appendix was excised on a level with the cecum. Examination of the specimen showed the mass was made up of the terminal portion of the appendix, hollowed out into a cavity the size of an almond, with the walls hypertrophied to nearly 2 inches in thickness, grayish, and lardaceous (Fig. 287). Histologic examination disclosed numerous tuberculous foci. Uneventful recovery.

He could find but 14 cases of this class in the literature where the disease affected the appendix alone. In some cases the focus in the appendix was the only one in the body, in others the lungs or the bowel elsewhere were involved.

The symptoms were those of an ordinary appendicitis, more or less acute, sometimes recurrent. The crises resembled those of enteritis, and nearly always there was chronic diarrhea and emaciation. In some cases the history was suggestive of tuberculosis, and in rare instances the increased size of the appendix could be detected by palpation. As a general rule, however, the tuberculous condition is not discovered until operation.

While intervention is indicated in all cases, the results are not favorable. Of the 15 cases, there were but 11 cures; fistulæ are frequent. The disease process may extend to the peritoneum or acute miliary tuberculosis may ensue.

Every case of supposed tuberculosis of the intestine should have a tuberculin test. A positive reaction, however, in the presence of a pulmonary tuberculosis would have no differential value as far as the abdominal lesion is concerned. When the clinical history and the positive reaction both indicate a tuberculosis in the intestine or appendix, the tuberculin treatment should be resorted to for months before any operative procedure is undertaken. By this means many of the cases can be cured without operation, and, above all, the peritoneum and intestine can be so much improved that resection of the cecum or appendix or occlusion with intestinal anastomosis may be performed, with as much security against fistula formation as we could have in the average operation without the presence of tuberculosis. The proper dosage of tuberculin is always an individual equation. There is no average dose, no regular dose; the temperature and reaction are the sole controlling elements as to how much or how little tuberculin should be given to obtain the best opsonic reaction. As a general guide, however, larger doses can and should be administered in the intestinal and peritoneal tuberculous lesions than are given when the disease involves the glandular or pulmonary systems. Virchow *never saw a case of completely healed tuberculosis of the intestine until he saw it produced by the use of tuberculin*, and under that treatment he observed many cases of completely healed tuberculosis of the intestine. The skepticism that exists concerning the curative effect of tuberculin is due to two causes: First, its improper dosage and administration and inaccurate observation by those who use it; and, second, expressions derogatory to its use by those who have had no experience with it and have nothing on which to base an opinion. *In my own experience it has a very positive curative value.* It should be used in all cases of intestinal tuberculosis as a postoperative treatment.

Actinomycosis of the Appendix.—This is probably more common than is usually supposed. Harbetz and Gröndahl collected 87 cases in Norway; 30 per cent. of these were in the abdomen, in which the primary lesion was in some part of the alimentary tract, most com-

monly in the appendix. Short reports 5 cases (4 females, 1 male) in patients from fourteen to forty-three years of age. He believes about 150 cases had been reported at the time of his paper, 27 of them being English; he thinks this is far from representing the real frequency. Many cases have been recognized, but not recorded, and it is highly improbable that the nature of the disease will be diagnosed unless the characteristic granules are searched for, and even then they are frequently absent in the discharge from the sinuses in undoubted cases. Of 650 affections of the right iliac fossa at St. Bartholomew's Hospital, 7 were due to actinomycosis; and of 380 cases at the Bristol Infirmary, diagnosed as appendicitis, 5 turned out to be due to actinomycosis. About 5 males were affected to 2 females. Young children escape, but after puberty every age is liable.

The symptoms are divided into four stages: (1) *Initial period of visceral manifestations.* This consists of vague pains in the iliac fossa on the right side, sometimes associated with intractable diarrhea, which may be of a mucomembranous type. The pain may be severe, and relapsing appendicitis will be the probable diagnosis. In this stage there are no local signs. (2) *Stage of tumor formation.* The characteristics of this stage are described below. (3) *Stage of fistula formation.* Abscesses burst or are opened in the neighborhood of the original site, and dark, fetid pus escapes. The granules may be found in the purulent discharge, though often absent, especially if the discharge is fecal. The best time to search for them is when a new abscess opens. This condition persists for months as a rule. Burrowing abscesses appear in the perinephritic, subphrenic, and even pulmonary zones. Death results from hectic fever and exhaustion. The extension results from continuity and not through the lymphatics. Occasionally there are metastases of hematogenous transmission. (4) *Stage of cicatrization,* when the fistulæ close and circumscribed or temporary cure results.

Before there is perforation and tumor formation the differential diagnosis can be made only by finding the actinomyces in the stools. When a patient past the age of puberty gives a history resembling that of chronic appendicitis, with a large, very hard mass adherent to the deeper structures and to the abdominal wall in the right iliac fossa, with mild temperature, slight pain, and little or no vomiting, actinomycosis should be strongly suspected. If, in addition, the skin is edematous, thickened, shiny, and of a purplish-violet color, the probabilities are great. The induration is out of all proportion to the quantity of pus in the focus. It is very woody and resembles the infiltration of a sarcoma or carcinoma much more than it does the infiltration around an infected focus, a characteristic of the disease in every position of the body. Moreover, when following appendectomies massive adhesions are found and secondary abscesses and fistulæ continue to make their appearance for weeks afterward in the neighborhood, especially if a subphrenic abscess of the right lung at its base is suspected, actinomycosis should always be considered a probable cause. The indurated character of the abscesses, so very little pus being obtainable from a

large swelling, is another diagnostic point. The actual confirmation of the diagnosis naturally depends on the finding of the actinomyces.

Tuberculosis or cancer of the cecum may sometimes be simulated by actinomycosis, but in the latter the mass is larger, more fixed, and there are no symptoms of obstruction. It may also be confounded with psoas abscess.

Short believes the prognosis is much less favorable than is admitted by English writers. His own cases have been peculiarly unfortunate, every one having eventually died. Of 77 cases, 22 were cured, 10 relieved, and 45 died. Of 13 recent cases, only 4 recovered.

Confronted with this very grave outlook, a determined effort must be made to remove completely all foci if the patient comes under treatment soon enough, unless such removal is quite impossible. The surgeon should be prepared even to remove the cecum and neighboring bowel, and, if need be, with formation of an artificial anus. There is a strong temptation merely to open abscesses as they point. This, however, usually allows the patient to progress to a stage where he is doomed. Unfortunately, it is generally quite impossible to eradicate the disease by a reasonable sacrifice. All that can be done then is to open abscesses as they point. Potassium iodid in large doses is usually given, and the wounds may be washed out with diluted tincture of iodin. Injections of tuberculin have been successfully used by von Eiselsberg and others. Arsenic and calomel appear to have done good also.

Bevan has treated actinomycosis with copper salts with good results. The ordinary rusts on grain can be readily destroyed by minute solutions of the sulphate, which seems to be the most powerful of the copper salts. He was induced to use it by the fact that it is very destructive to vegetable parasites and is also well borne by animal organisms. In one case Bevan began with $\frac{1}{4}$ gr. *t. i. d.*, then increased it to $\frac{1}{2}$ gr., while some patients were given 1 gr. *t. i. d.* The lesions were irrigated with a 1 per cent. copper sulphate solution. It has been shown by French observers that copper sulphate can be administered in doses from 2 to 8 gr. a day for months at a time without deleterious effects.

A patient with abdominal actinomycosis, in whom an enormous lesion filling the entire pelvis developed, was operated on and an abscess-cavity opened; fistulæ were discovered extending in all directions. He was placed on large doses of potassium iodid, but in spite of this suppuration continued and fistulæ continued to develop. He was then placed on copper sulphate internally and by irrigation. The granules could be found in the pus at almost any time. There was extensive infiltration of the recti muscles, fistulæ had been developing at all times, but at the date of report this process had almost entirely cleared up. The patient had gained 20 pounds in six weeks under this treatment.

It may be, adds Bevan, that as in syphilis, where certain cases are better handled by the " mixed " treatment, so in actinomycosis, it may be shown by further trial that the mixed treatment of copper and iodin may prove the more effective in certain cases.

Cysts of the Appendix.—The lumen of the organ sometimes becomes obliterated at one point, when the distal portion dilates and forms a retention cyst; occasionally there is obliteration at two places and the intervening segment becomes cystic. These cysts are of various dimensions; one removed by Baudrimont was the size of the terminal phalanx of the thumb; in some cases they grow to an enormous size. Elbe refers to one removed from a woman of fifty-two which was as large as a child's head—5.2 by 7.2 inches.

The walls of the cyst on histologic examination show the usual structure of the appendix, though the layers are much thinned and spread out, often on the point of rupture. At first the contents are composed of mucus, but as the stretching continues, with atrophy of the wall, the secretion of mucus ceases and the fluid is transparent and watery (a regular pathologic change when columnar cells are flattened through pressure). In Elbe's case, just alluded to, the contents con-

FIG. 288.—CYST OF APPENDIX. (Baudrimont.) Showing appearance after stay in alcohol: *a*, Incision made after removal.

FIG. 289.—SAME, ON SECTION. (Baudrimont.) Schematic drawing showing the relation of the cyst to the appendical lumen.

tained the colon bacillus, though in another they were sterile, and from a bacteriologic standpoint the contents seem to be but slightly virulent. The outer surface of the cyst is generally quite vascular, it may be smooth or adherent, and, owing to the tension of the contained fluid, diverticula may form and project from the surface.

There is nothing characteristic about the symptoms, which correspond with those of ordinary acute or subacute appendicitis. For example, Baudrimont's case was that a of young girl of sixteen, who had the primary crisis in 1906, six months later a second, and the third in October, 1908. At the operation, Dec. 16th, the appendix was found adherent to the coils of the small bowel, from which the dilated portion was distinguished with difficulty. The portion of the organ next the cecum was of about normal size, but suddenly became dilated about the middle, the wall varying from $\frac{1}{16}$ to $\frac{1}{4}$ inch in thickness (Figs. 288, 289). Microscopic examination showed obliteration of the lumen by a fibrous partition; below this was the cystic dilatation with the mucous coat

much thinned, and the whole wall—especially the submucosa—slightly infiltrated with leukocytes. In addition, there was much sclerosis of this portion. The area which was still patent and in communication with the cecum exhibited marked folliculitis and perifolliculitis. Baudrimont believes the sequence of affairs was as follows: At the primary attack a small ulcer formed the focus for an active cellular proliferation which finally closed the lumen; below this the mucosa continued to pour out its secretion, giving rise to a retention cyst. On the other hand, the segment above the obliteration in connection with the cecum and still the seat of infection was the point of origin for the last two attacks.

The treatment is the same as that for appendicitis.

Sarcoma of the appendix is a decidedly rare affection of the organ, less than a dozen cases being recorded, the first in 1893. Further proof of its rarity is afforded by Powers, who states that no instance of primary sarcoma was discovered among 7000 appendices removed at the Mayo clinic. This author, furnishing the report of a recent case, refers to 7 others, and a few months later Wright added 2 more, one of them personal.

As usual in cases of sarcoma elsewhere, the patients were comparatively young: 1 being a boy of six, 2 aged seventeen, and so on; the oldest was a man of fifty years. Only 3 in the series were women.

The majority of the cases (6) were of the round-celled variety, 2 were spindle-celled; 1 was fibro-, and 1 lymphosarcoma. Wright observes that the process seems to begin in the submucous coat and extend out into the muscularis, the mucosa being next affected, while the serosa is not involved for a long time. The whole of the organ was involved in 6 cases, and in 2 the growth had spread to the surrounding parts. In several instances the neighboring lymph-nodes were the seats of metastases. While some authors deny the occurrence of sarcoma of the appendix, there is no room for doubt in the cases of Powers and Wright, the specimens being examined by Prof. Welch, of Johns Hopkins University, and Prof. Lorrain Smith, of Manchester University, respectively.

None of the cases was so diagnosed before operation. The patients usually sought treatment for recurrent pains in the region of the appendix. Carwardine's patient, a woman of forty-five, had colic and diarrhea with emaciation for five months, while Wright's case was operated on for acute obstruction originating in an intussusception, apparently starting from partial invagination of the appendix. Glazebrook's case was discovered accidentally at necropsy in a negro man of fifty-five who died from apoplexy.

Simple appendectomy was done in 5 cases; part of the cecum was removed with the appendix in 2 instances. In Wright's case in a boy of seventeen malignancy was suspected from the appearance of the parts at operation, and as it was necessary to interfere with the blood-supply of the colon to remove the nodes thoroughly, the cecum, ascending colon, appendix, nodes, and terminal portion of the ileum were removed *en masse*. The ends were then closed and a side-to-side anastomosis established.

The end-results thus far have not been very good. One patient died in a few hours from shock; another, of recurrence in nine months. Powers' patient died ten weeks later from general abdominal sarcomatosis. One case was free from recurrence five months after operation, and Wright's case was apparently in good health thirty months later. Practically the only recovery was the case of the six-year-old boy (Warren), in good health four years after operation.

Carcinoma of the Appendix.—This variety of malignant growth is a good illustration of the fact that when active search is made for them, like many other supposedly rare conditions, they are, as a matter of fact, rather frequent. In 1900 Hurdon could find but 10 cases in the literature; in 1903 Elting had collected 24 cases; in 1908 McWilliams enumerated no less than 108.

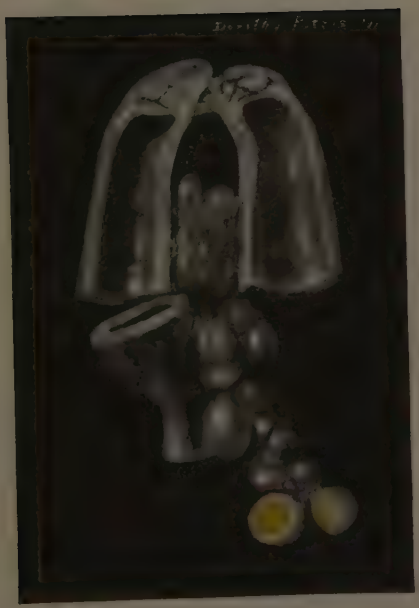
Kennedy, in the routine examination of 350 appendices removed at necropsy, found but 1 case of primary carcinoma, this was from a woman of forty-two, dying from cirrhosis of the liver. In 2 cases metastases were found by him from a gastric carcinoma. MacCarty and McGrath discovered carcinoma in 22 of the 5000 specimens examined by them. In nearly all of these (17) they were not extensive enough to be seen on the peritoneal coat nor to cause any enlargement, hence diagnosis by the surgeon would have been impossible. It is interesting to note the incidence per 1000 in their series was practically the same, being 5, 7, 3, 2, and 5 respectively.

In cases collected by Harte, 17 were under twenty years of age; 34, from twenty to thirty; 21, from thirty to forty; 11, from forty to sixty; 5, over sixty. The youngest patient in MacCarty and McGrath's series was a girl five years of age, and the oldest a man of eighty, in whom the carcinoma was found accidentally at necropsy after operation for vesical calculus. For some unknown reason females are more liable to the disease than the opposite sex—59 : 41 (Harte); 73 per cent. females, 27 males (MacCarty and McGrath).

Concerning the structure it may be said that the majority are simple carcinomata. The tumors investigated by the authors last named consisted of alveoli filled with epithelial cells, the nuclei of which were in general oval or round, and presented fewer irregularities than is usually found in carcinoma of other portions of the digestive tract. According to these authors the size and lack of marked irregularity on the part of the nuclei, as well as the alveolar arrangement and staining qualities, have been the cause why some observers call these growths "endotheliomata" and "basal-cell carcinomata." Adenocarcinoma is not so frequent and the colloid variety is quite uncommon. White has lately reported one in a woman of seventy-five who died of intestinal occlusion. An adenocarcinoma was found which had undergone colloid degeneration in several places, as had a node in the ileocecal angle. The size of the growths is small, that of a pea or bean, rarely larger (Plate VII.).

Carcinoma, unlike tuberculosis, involves the tip rather than the base of the appendix, and 90 per cent. in MacCarty and McGrath's series were found in this location. They believe it occurs here

PLATE VII.



CARCINOMA OF APPENDIX. (MACCARTY AND MCGRATH.)

Specimen showing partial obliteration of the distal portion with dilatation of the rest of the appendix to within 1 cm. of the cecum, at which point there is complete obstruction. The orange-colored area in the obliterated portion is carcinoma.

in association with a chronic inflammatory process, as it is more frequent at the tip, the point of activity in the process of obliteration. One of Kennedy's cases was found in connection with an obliterated organ in a woman of forty-two, and in the other two, from a man of forty-nine and a woman of twenty-three, there was stricture of the appendix.

This brings up the question of benignancy of these neoplasms. They are generally circumscribed and metastases are unusual, as are infiltrations in the vicinity. Of 90 cases, secondary growths occurred in only 6 (McWilliams). Thus, of 20 examples of carcinoma of the cecum examined by MacCarty and McGrath, but one might have originated in the appendix. Lejars and Bevan have reported 2 cases that terminated fatally. The relatively mild malignancy of appendical carcinoma has been explained in various ways: the different structure of the growths; the growth being, so to speak, outside of the intestine, and not exposed to irritation; that the obstruction of the lumen of the organ causes symptoms of appendicitis and thus leads to an early removal, etc. The lymphatics in the tip of the appendix are few and the disease is, therefore, not prone to metastasis.

The true nature of these tumors is summed up in an editorial in the *Journal of the American Medical Association*, January 14, 1911, as follows:

"True malignant epithelial growths do occasionally, but rarely, arise in the appendix, and their occurrence is probably favored by chronic inflammatory processes. . . . As a result of chronic appendicitis we also have a snaring off and displacement of epithelium, which may proliferate to some degree, forming atypic epithelial growths which are not true carcinomas, but which may resemble carcinoma closely, and into which they may also become transformed. Similar structures may also be produced by congenital malformation or displacement of the epithelial structures of the appendix. . . . Finally, as a result of chronic infection, the endothelium of the lymph-channels of the appendix may proliferate in such a manner as to produce appearances strongly suggestive of cancer infiltration. The chief conclusion to be reached is that surgeons should appreciate as well as the best pathologists do the limits of our ability to decide positively from microscopic appearance alone the malignant or non-malignant character of each and every growth; and also that, especially in the appendix, we encounter not only true carcinomata, but also much more frequently epithelial proliferations which exhibit all the usual histologic criteria of malignancy without necessarily or commonly causing the clinical results usually associated with cancer."

Kennedy likewise suggests that his 3 cases are of considerable interest in view of Ribbert's theory as to the etiology of tumors, viz., that "tumors arise from a partial or complete separation of cells, or groups of cells, from their organic continuity, that is to say, from mechanical isolation."

The symptoms, as might be expected, are those of appendicitis, and in the series from the Mayo clinic the average duration of the symptoms was 3.3 years.

Since the discovery of the carcinoma is usually made after removal of the organ, simple appendectomy has been the method of operating resorted to in the majority of cases without glandular resection, and still the cases remained well or were cured.

If the growth is visible to the naked eye the possibility of cancer should be borne in mind and free excision of the meso-appendix done. As has been seen, this was the case in only about 25 per cent. of MacCarty and McGrath's series, and about the same in McWilliams' collection. Partial removal of the cecum is only indicated where the proximal portion of the appendix is involved.

Appendicostomy and Transplantation of the Appendix.—The first of these was originated by Weir in 1902 for the relief of obstinate colitis. The late C. B. Keetley, of London, was an enthusiastic advocate of the operation, and summed up his experience in a paper shortly before his demise.

He first points out that the use of appendicostomy practised or suggested up to that time may be tabulated as follows: (1) Colitis of various kinds; (2) certain varieties of intussusception, to prevent recurrence, etc.; (3) intestinal hemorrhage; (4) typhoid fever; (5) cases of enterectomy and colectomy as a safety-valve; (6) intestinal distention in toxic conditions; (7) the administration of nutrient enemata; and for (8) constipation. An additional indication is as constituting part of the technic in transplanting the whole or greater part of the organ into the abdominal wall instead of performing appendectomy.

The objects of his paper were to show (*a*) that transplantation of the appendix, so that the whole or the greater part of it from its cecal attachment lies permanently embedded in the abdominal wall, will produce the good results of excision; (*b*) that it is practicable and safe; and (*c*) that transplantation should in many cases be preferred to appendectomy (an opinion to which we take exception). This also adds a potential surgical value to the functions of the appendix.

Technic.—The first steps are not different from those for appendectomy, though the upper end of the parietal incision should not be too low or too near the middle line, or there will be an increased possibility of the base of the appendix not coming up to the wound without tension. Transplantation of the appendix is a plastic operation and avoidance of tension is one of the first rules in plastic cases. An appendix and cecum which do not readily and easily come to the surface when first exposed can often be persuaded to do so by patience and a little gentle traction, especially if abnormal adhesions or peritoneal connections be freely separated, or if the parietal incision be extended upward and outward. Care must be taken of the free margin of the meso-appendix which contains the main appendical artery.

If the appendix be kinked, a little patient stretching will sometimes straighten it out; if twisted, it may be untwisted; but it must not be squeezed too tightly or seriously bruised. Small or movable concretions may be pressed toward one end of the organ or the other, large ones squeezed out through a short longitudinal incision, which can be cleaned and closed again. In such cases the distal end of the appendix should be opened as soon as the operation is concluded.

The appendix should be laid in an easy position obliquely in the abdominal wall, by preference, with its apex up and out. Its base should

lie beneath the middle or upper third of the wound, and frequently a special button-hole be made through the skin for the apex of the appendix to go through and a passage burrowed beneath the fat between the original wound and this button-hole. The cecum itself close to the base of the appendix should be fixed to the edge of the peritoneum either by several interrupted sutures or by a simple continuous one. If the latter is used, care must be taken not to strangulate the appendix, and the suture should be carried through the meso-appendix, not around the appendical artery.

If the meso-appendix is thick or wide it may be button-holed and the peritoneal edges stitched together through it; one stitch may suffice

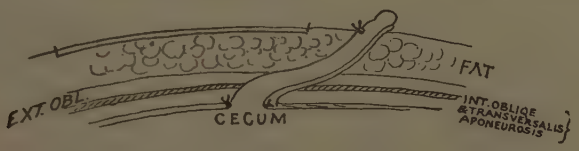


FIG. 290.—TRANSPLANTATION OF THE APPENDIX. (Keetley.)
The muscular layers are placed in this diagram rather wide apart to prevent confusion. This exaggerates the S-curve of the transplanted appendix.

for this. The rest of the peritoneal wound should now be closed with a continuous suture. The transversalis and external oblique must next be sutured successively in such a way that more of the appendix lies beneath the latter, as shown in Fig. 290. Then with a fine catgut suture, not drawn tightly, persuade the fat to cover all the rest of the appendix except $\frac{2}{5}$ inch of the distal end, which is left projecting beyond the skin, and united to the latter by a single suture of silkworm gut. The cecum also may be fixed to the parietal peritoneum to insure against retraction of the appendix.

To prevent gangrene, (1) Do not open the appendix until it has adhered to its bed, say, for about forty-eight hours; (2) do not leave a catheter in unless necessary, and then a very small one; (3) take every care to keep the wound aseptic and unpolluted.

FIG. 291.—SAME: OPENING APPENDIX.

The appendix is quite insensitive and its division needs no anesthetic. It can, therefore, be dealt with in several stages. It is generally best opened by simply cutting it nearly in two (Fig. 291). Then with a pair of forceps on the distal lip of the notch, and after hemostasis, the catheter is usually passed in. Ultimately the tip is cut off altogether, level with the skin, if there is no indication to keep the appendicostomy wound open. If the appendix is to be used for injection for weeks or months, then it should be treated as follows: Cut away the seromuscular coat (Fig. 292) down to the level of the skin, beginning with a circular cut at that level and continuing with a longitudinal one. The seromuscular coat then easily strips off. Next turn back the mucous-submucous lay-

ers like a coat sleeve, and a neat little nipple results. This usually diminishes in size, the mucosa becomes skin-like, and the lumen is easily found when wanted at or near the summit of the nipple. Where the meso-appendix is thick the aperture is sometimes lateral. In exceptional cases the mucosa prolapses a little; if so, it is easily trimmed off.

In order to reopen a transplanted appendix which has been disused for some time the procedure depends on the condition. If even a pin-hole opening remains it can be dilated, sometimes almost without pain, even without local anesthesia, first using a very fine probe, then a pair of sinus forceps, then a pointed catheter. In such cases the contraction is generally confined to the skin, the middle and proximal portions remaining open. Force should only be used in dilating the cutaneous aperture by opening the blades of the sinus forceps. When once the soft-rubber catheter is in the right place, it may be pushed on boldly.

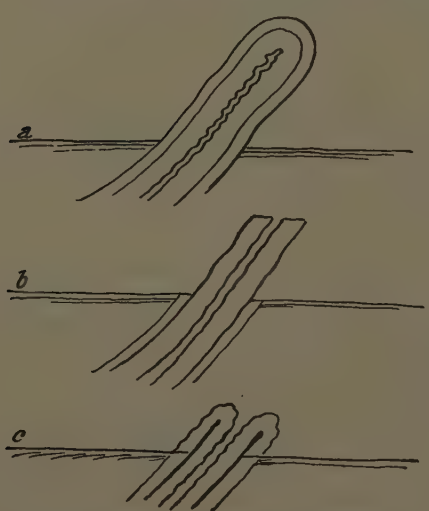


FIG. 292.—TECHNIC OF FORMATION OF PERMANENT APPENDICOSTOMY OPENING. (Keetley.)

a, Fixation of appendix in skin wound; *b*, seromuscular coat removed; *c*, mucous-submucous layer turned back.

Keetley gave it as his opinion that appendicostomy is the best surgical treatment for constipation thus far devised. It proved unfailing with him; one or two of the most obstinate cases he had met with or read of yielded to it at once, and in cases where he had not performed the operation for constipation, but in which the latter had existed or occasionally complicated the course of the case, the injection of diluted aperients had speedily given relief. Often the mere injection of warm water through the appendix sufficed.

A very important question is: Will the subject of an appendicostomy for constipation have to use his appendix for the rest of his life in order to maintain the action of the bowel? On this point Keetley reserved his opinion, since the first operation of this kind was less than four years old. It was not necessary, however, to increase the strength of the purgative solutions through the appendix. On the contrary, it has generally been found possible to diminish it. Sometimes it has been found that plain water in sufficient quantities ultimately sufficed. He believed a patient suffering from constipation, if intelligent and willing to obey rules as to diet and exercise, even if it were found necessary or advisable to do an appendicostomy, would, after that operation, have a better chance of being cured by an experienced physician than before.

Strictly speaking, this operation is not in itself a remedy for constipation, but one which facilitates the employment of remedies. The condition of the patient on whom this procedure was first carried out thirty-nine months previous was the following: She secures a movement when she chooses to take a suitable pill or can find time to give herself an enema. This may not seem much of a triumph, but Keetley adds, Before the operation the physician could not obtain a movement for long periods, in spite of the combination of enemata with powerful purgatives. Her appearance and well-being are vastly improved.

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CHAPTER CXXVII.

HERNIA.[1]

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Operations for the Radical Cure of Hernia.—Since the publication of Vol. IV. (p. 17) in 1908 there have been no new methods of operation brought out worthy of special mention other than Downes' operation for direct hernia, which is fully described later in this chapter.

I still believe that the Bassini operation, as described in my former chapter, is distinctly superior to all other operations for the cure of inguinal hernia, either of the direct or indirect type. For years there have been a number of surgeons who believe that the transplantation of the cord in Bassini's operation was of little or no value. The method of operation variously known as the Wölfler, the Ferguson, the Hospital for Ruptured and Crippled operation (Bull-Coley), which is essentially the same as Bassini's operation without transplantation of the cord, has had and still has many advocates, but I believe that the statisctis of Wölfler's own clinic just presented, if compared with those of the Hospital for Ruptured and Crippled, will settle beyond question the superiority of the original Bassini operation. It is impossible accurately to estimate the value of any method of operation from the results of operation obtained by different men, but, fortunately, at the Hospital for Ruptured and Crippled, we have a large series of cases in which the cord was not transplanted to compare with a similar series in which the cord was transplanted, and in which the operation was done by the same group of men. Such comparison shows a distinct advantage in favor of Bassini's method (transplantation of the cord).

As regards femoral hernia, I still believe the simple operation of high ligation of the sac, with careful removal of all extraperitoneal fat and closure of the femoral canal by purse-string suture with kangaroo tendon, to be the best method. I have personally operated upon nearly 200 cases of femoral hernia with only 1 relapse.

Suture Material.—Numerous attempts have been made to substitute silver wire, linen thread, and silk for the absorbable sutures of kangaroo chromicized tendon and catgut. I am still very strongly opposed to such substitution. Since 1891, 3383 hernia operations have been performed at the Hospital for Ruptured and Crippled, and in the entire number, with the exception of the first 20 cases, absorbable sutures were used, nearly all chromicized kangaroo tendon and, in a few cases, chromic catgut. These cases have been very carefully traced, and

[1] Supplementary to Chapter LIII., Vol. IV., p. 17.

there has been less than 1 per cent. of relapses in the entire number. This is a much higher percentage of permanent cures than has ever been obtained by the use of non-absorbable sutures, either here or in Europe.

Results of Operation for the Radical Cure of Hernia.—One of the largest and most complete statistics of operations for the radical cure of hernia is that of Hilgenreiner,[1] embracing 2238 cases observed at Wölfler's clinic (Prague) from 1895 to 1910, *i. e.*, 1460 free and 778 incarcerated herniæ; 71 per cent. of the total number of cases occurred in men, although 88 per cent. of the crural and umbilical herniæ occurred in women. In the incarcerated cases the proportion of female cases amounts to 56 per cent.

The operation employed in nearly all of the cases of free hernia was the Wölfler method, which he states is practically the same as Bassini's, the only difference being that the cord is not transplanted, and that in cases in which the internal oblique seems poorly developed the rectus muscle is made use of to strengthen the anterior wall of the inguinal canal.

With regard to fatalities following operation, Hilgenreiner states that in 1460 operations done upon 1268 patients with free hernia, there were 8 deaths, giving a mortality of 0.63 per cent., while in the 778 operations for incarcerated hernia the mortality was 19.4 per cent.

With reference to late results, Hilgenreiner states that the proportion of relapses given in his last statistics at 8 per cent. is too high; he believes that 5 per cent. would be more nearly correct.

Danger of Taxis.—He points out the danger of taxis; not less than 14 cases having come to the clinic after *en bloc* reduction of an incarcerated hernia, and 6 after reduction of the gangrenous contents. That too severe and prolonged taxis is still practised in most clinics is shown by the high mortality of operations for strangulated hernia. In striking contrast to this should be mentioned the statistics of van Assen,[2] covering 100 cases of strangulated hernia operated upon at the Amsterdam Clinic between the years 1903 and 1906, without preceding taxis, with only two fatalities. One of these was a patient eighty-one years of age.

While van Assen states that nearly all cases were operated upon within the first few days after the onset of the symptoms, the fact that 4 cases were below one year, 18 between fifty and seventy, 17 between seventy and eighty, and 3 above eighty years, shows that some of the cases certainly were not particularly promising for operation.

The importance of the use of local anesthesia in cases of strangulation, particularly in subjects of advanced age, is also shown by van Assen. Inhalation anesthesia was used in 32 and local anesthesia in 62 of the cases.

I have seen a number of cases in which death resulted from taxis. I believe that the time has come when it would be a safer rule to abandon taxis altogether in all cases of strangulated hernia where the strangula-

[1] Beitr. klin. Chir., Dec., 1910.
[2] Ibid., 1909, Bd. lxv., Heft 2.

tion has existed more than three to four hours, provided that an early operation can be performed under favorable conditions. The longer the strangulation has existed, the more dangerous is taxis. The dangers of taxis are further emphasized by Sänger,[1] who reports no less than 5 ruptures of the gut due to taxis in a series of 165 cases operated upon within the last three and one-half years at v. Bruns' clinic; 3 of the cases died, while 2 were saved by resection of 7 and 130 cm. of gut. Sänger has collected 35 cases of rupture of the gut due to taxis. Of the cases operated upon, 22 in number, 10 (45 per cent.) recovered; 12 (55 per cent.) died. All cases not operated upon died of peritonitis, the latter being present also in all but one of the cases operated upon.

Statistics.—At the Hospital for Ruptured and Crippled, from December, 1891, to January, 1912, we have observed 3383 cases of hernia of the following varieties:

Inguinal Hernia in the Male—

Indirect	2470, with 20 (0.81 per cent.) recurrences.
Direct	10, without recurrences.

Inguinal Hernia in the Female—

Indirect	617, with 8 (1.29 per cent.) recurrences.
Direct	3, without recurrences.
Femoral	141, without recurrences.
Umbilical	74, with 3 (4.0 per cent.) recurrences.
Ventral	55, with 8 (14.4 per cent.) recurrences.
Epigastric	12, with 1 (8.3 per cent.) recurrences.
Lumbar	1, without recurrence.

The foregoing table shows 40 relapses in a total of 3383 cases of various types of hernia, which is equal to 1.18 per cent. of recurrence.

Bassini's method was employed in 1859 cases of indirect inguinal hernia in the male, with 10 (0.53 per cent.) recurrences. The cord was not transplanted in 621 cases, with 10 (1.61 per cent.) recurrences.

In the direct inguinal hernia in the male, 10 in number, Bassini's method was used without any recurrences.

The method employed for femoral hernia is the so-called "purse-string method," *i. e.*, high ligation of the sac with closure of the canal by purse-string suture.

For the umbilical herniæ, Mayo's or the overlapping method was employed in 43 cases, with 1 relapse (2.34 per cent.); the method without overlapping in 31 cases, with 2 recurrences (6.4 per cent.).

There were 52 cases of superficial inguinal hernia, without recurrences; 193 associated with undescended testis, without recurrences; 31 cases of strangulated hernia, with 1 (3.2 per cent.) relapse.

The total number of deaths in the preceding series of cases was 6, or a mortality of 0.17 of 1 per cent. Of these, I personally operated upon 1340, with 3 deaths.

In addition to these cases I have operated upon upward of 1500 cases outside of the hospital, 1400 of which were in adults, with only 1 death and 15 relapses.

[1] Beitr. klin. Chir., May, 1910, Bd. lxviii., Heft i.

Hernia Associated with Undescended or Maldescended Testis.—This subject has received considerable attention during the last five years, and yet surgeons throughout the world are by no means in accord as to the proper treatment of this condition.

Rawling[1] published an analysis of 120 cases of undescended testis admitted to St. Bartholomew's Hospital during the preceding five years. In 90 per cent. of the cases the condition was associated with a hernia. My own experience is that it is practically always associated with a hernia, as I have seen only 2 instances to the contrary in an experience covering nearly 200 cases. Rawling's paper is extremely valuable for the amount of information it contains as to the actual condition of the imperfectly descended testis. In no less than 50 cases the testis was removed, and in 27 of these a careful microscopic examination made. In 15 the changes were characteristic of ill-developed and atrophic testes, with an increase of fibrous tissue and deficiency of epithelial elements and defective or absent spermatogenesis. In 10 cases there was little alteration from the normal and definite spermatogenesis was present. Four methods of treatment were employed: (1) Placing the testicle in the scrotum; (2) allowing it to remain in the canal; (3) replacing it in the abdomen; (4) removing it. In 21 cases of primary inguinal retention, attempts were made to place the testicle in the scrotum. Results show that 5 returned into the inguinal canal; 6 ascended to the pubic bone; 6 others became pubic-scrotal, and only 4 remained in the scrotum.

Of 8 examples of pubic retention, 6 returned to the pubic region and 2 became pubic-scrotal.

Thus, of 29 cases in which an attempt was made to transplant the testicle into the scrotum, only 4 were successful.

Rawling concludes that attempts to place the testis in the scrotum usually result in failure; leaving it in the canal renders it more liable to malignant degeneration and torsion of the cord, and as replacing it in the abdominal cavity destroys all chances of spermatogenesis, there remains then but one method of procedure, *i. e.*, the removal of the testicle and complete closure of the canal. This he regards as the method of choice.

In most cases he would not operate before the seventh year, but in all cases after this age, and in such cases in which the testicle could not be easily replaced in the abdomen, he would remove it, with one exception, *i. e.*, the condition of double undescended testis. In these cases he advises attempting to place the testicle into the scrotum, running the risk of retraction of the testis into the pubic or pubic-scrotal region in order to give the individual the benefit of what chances there are of retaining the functional power of the testicle. In double undescended testis he advises operation before the age of puberty.

I believe Rawling's position regarding the routine sacrifice of the testicle in these cases far too radical, and I think it marks a step backward in the treatment of the condition. During the past twenty years a

[1] Practitioner, London, August, 1908, p. 250.

sufficient number of operations for this condition have been performed and traced to final results to convince one that the sacrifice of the testis is absolutely unnecessary and, in most cases, unwarranted.

Tuffier, in 1890, published an admirable method of operation with a report of 7 personal cases, all of which were traced; one showed a perfect result more than a year after operation; in the other 6 all pain and discomfort had ceased, although the testicle showed more or less tendency to retract toward the external ring. Of 4 cases operated upon by Tuffier's colleagues, 2 showed perfect results.

In 1899 Broca[1] followed Tuffiier with a paper reporting 138 cases, 79 of which had been traced from one to six years after operation. He found it necessary to remove the testicle in only a single case; 31 of these 79 cases showed perfect results, the testicle having remained in the scrotum. In no case was there a relapse of the hernia.

Bevan[2] in the same year published a method of operation which was an improvement on any that preceded it. His results have already been published in Vol. IV., p. 592. He was the first to advocate the complete removal of all the vessels except the artery of the vas, in cases in which the testicle could not be placed in the scrotum without their sacrifice.

We have never had a recurrence of the hernia in 193 cases of operation for undescended testis associated with hernia at the Hospital for Ruptured and Crippled, nor have I seen any recurrence in my own 168 cases, 68 of which were in adults and 100 in children.

As regards the more important point, the final position of the testicle, the results have not been so uniformly good. As one becomes more familiar with the technic of the operation, the testicle remains in the bottom of the scrotum in a larger proportion of cases; in a considerable number, however, the testicle retracts to the upper scrotum or neighborhood of the pubic bone; but, if the operation has been carefully performed, it can never enter the narrowed external ring.

As to the growth of the testicle subsequent to the operation, if the operation is performed before the age of puberty, I believe that the testicle in many cases undergoes normal development. I am very strongly opposed to operation in undescended testis in very young children, for in many instances of abdominal ectopia in early childhood I have seen the testicle at the age of eight to ten years, and especially when nearing the approach of puberty, enter the canal and even find its way below the external ring, making the operation much easier than had it been done earlier in life. In many of these cases the testicle is almost normal in size.

As regards operation, I believe that the method of Bevan (Vol. IV., p. 592) is the best.

The method we have employed at the Hospital for Ruptured and Crippled since 1891 is Bassini's operation, without transplanting the cord, practically the same as Bevan's, except that until the publication of his method we had never dared to sacrifice all the vessels of the

[1] Gaz. des Hôp., March 1, 1899, p. 316.
[2] Jour. Amer. Med. Assoc., Sept. 23, 1899.

cord except the vessels of the vas. Since then we have in a small number of cases, perhaps a dozen, carried out this step without any untoward result thus far.

The *inguinosuperficial* type of hernia, which is practically always associated with undescended or maldescended testis, has been found in recent years to be much more frequent than was formerly supposed.

FIG. 293.—STRANGULATED CONGENITAL HERNIA OF THE INTERSIGMOID FOSSA IN A CHILD THREE DAYS OLD.

Moschcowitz stated that he could find only 17 cases reported in the literature.

In an article upon this variety of hernia Büdinger[1] reports 16 cases that he had himself observed. He states that in this form of hernia the vaginal process after passing out of the inguinal canal is drawn abruptly upward toward the anterior superior spine, and rests upon the external surface of the aponeurosis of the external oblique muscle.

[1] Arch. klin. Chir., Bd. 95, Hft. 1, May, 1911.

At the Hospital for Ruptured and Crippled we have operated upon 193 cases of undescended testis associated with hernia, and in 47 cases it was of the superficial inguinal type. All of these patients were children under the age of fourteen years.

I have operated upon 168 cases of undescended testis: 95 in the Hospital for Ruptured and Crippled and 73 cases outside the hospital, of which 57 cases were of the inguinal superficial type; of these, 25 occurred in 68 patients over fourteen years, and 32 occurred in 100 children under the age of fourteen years.

Rare Types of Hernia.—Among the rarer types of hernia may be mentioned the case of strangulated retroperitoneal hernia of the intersigmoid fossa which I reported before the meeting of the American Surgical Association in June, 1909.[1] My patient was a male infant, weighing 7½ pounds when born, Sept. 8, 1907, and was in every way apparently normal at birth. Symptoms of intestinal obstruction set in eighty hours after birth, the child developing a temperature of 102° F., and began to vomit. The patient died about twelve hours later. The condition found at autopsy is well shown by Fig. 293. There was a pint of yellowish liquid feces in the abdominal cavity; almost the whole intestine was lying in the retroperitoneal pouch. This is, I believe, the third case of its kind on record and the only one in an infant.

FIG. 294.—STRANGULATED INTERSTITIAL HERNIA IN THE FEMALE.

Krall[2] reports what he believes to be the fourth case, so far known, of *incarcerated intersigmoid hernia*. This patient was thirty-three years of age, and was admitted to the Heidelberg Clinic, Nov. 18, 1910, with symptoms of intestinal obstruction. On operation the large intestine was found. Krall believes this to be the only case of hernia of the intersigmoid fossa in which the large intestine was found, and the only one that was cured by operation.

Interstitial Hernia in the Female.—Since the former chapter was written I have done several operations for rare types of inguinal hernia in the female. One of these was a multiple cyst of the canal of Nuck in a patient forty-one years of age. The swelling had existed for several years. Operation showed four cysts of various sizes not communicating with one another (Fig. 294).

[1] Annals of Surg., July, 1909. [2] Deut. Zeit. Chir., June, 1911.

Another case was that of a properitoneal hernia in the female, which was reported in my paper in the Annals of Surgery, September, 1909.

Our knowledge of interstitial hernia is based chiefly upon the exhaustive paper of Göbell (Deutsche Zeitschr. f. Chir., lvi.). Of 115 cases collected by him, only 4 occurred in women.

Cumston states that in the 11 cases collected by him up to 1900, not a single one was found in the female. He reports a personal case occurring in a girl of nine.

Müller (Inaugural Dissertation, 1901) collected 200 cases of inguino-interstitial hernia, of which 162 occurred in men and 38 in women; 129 of the male and 34 of the female are included in Macready's statistics of reducible herniæ. They were not operated upon nor was autopsy performed; hence, all anatomic data are absent. In the remaining cases the histories are sufficiently explicit to enable one to determine in which interstices of the muscles the sac was found. Most frequently it was noticed between the external and internal oblique, and of this variety only 12 cases (including Müller's) are known. My own case makes 13 (Fig. 295).

Traumatic Hernia, or the "Hernia of Accident."—While the relation of injury or accident to a hernia was discussed rather fully in Vol. IV., p. 38, the subject is one of growing importance which is more clearly recognized each year.

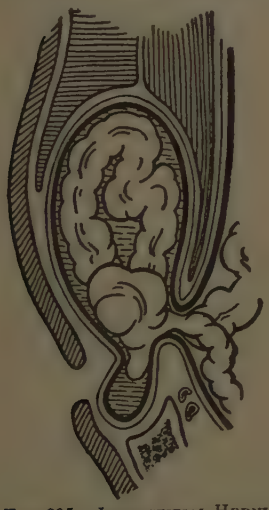

FIG. 295.—INTERSTITIAL HERNIA IN THE FEMALE. (Coley.)

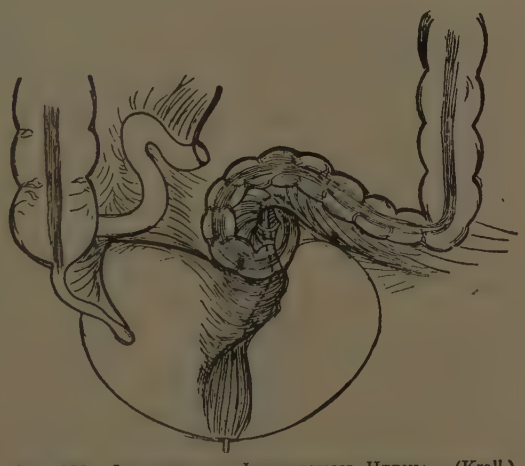

FIG. 296.—INCARCERATED INTERSIGMOID HERNIA. (Krall.)

One of the most interesting studies of the subject from a medicolegal standpoint is that of Sheen,[1] who states:

"Excessive strain must be regarded as an injury" epitomizes a judgment of the House of Lords, the highest legal tribunal in England, and it is to "excessive strain," generally from lifting, that a workman commonly attributes his hernia or "rupture," as it is, as a rule, wrongly and most unwisely termed. Now, no one doubts that a working life which, day after day exhibits "excessive strains" is a life which contributes to the production of hernia, but this is not sufficient to constitute hernia as an accident within the meaning of a "Compensation Act." When, if ever, is the surgeon justified in supporting the view of the workman that the hernia from which the latter suffers is due to a single

[1] Practitioner, London, 1909, vol. lxxxiii., p. 334.

"strain"? He states that often nothing may be felt at the time of the supposed strain; it may be days or weeks after the latter before he discovers the hernia. When found, it may be large or small; it may be attributed not to a strain, but to a blow in the groin, abdomen, or elsewhere or to some other cause. The presence of a double hernia is sometimes attributed to a single strain. Sheen believes that such associations of strain and hernia as cause and effect are fallacious, although he does not think that the workingman, as a rule, intends to practice deception, but is influenced (1) by a desire to find a cause for the trouble; (2) by the common use of the word "rupture" instead of "hernia," which produces in the mind the idea that the condition is one due to violence or injury. Sheen believes that the sudden first appearance of a hernia, in the sense that it constitutes an accident arising from excessive strain, is very rare, but not an impossibility. He states: "I consider that its sudden complete development in a pathologic sense is impossible, because the peritoneum cannot stretch suddenly to form the sac. The peritoneum is incapable of sudden, but is capable of very great gradual, extension; it is only the sudden clinical development of a hernia which is possible, and what happens is the sudden projection of a small amount of contents into an unobliterated funicular process, the process being of such size and laxity as to be able at once to constitute a definite sac. The cause of this is most likely to be a straining in an unnatural attitude—ordinary straining efforts close the inguinal rings. Localized blows cannot cause a hernia.

"The sudden projection of hernial contents into the preformed sac is accompanied by definite immediate symptoms. The affected individual suffers acute pain at the site of the hernia, at once undoes his clothes, finds a small lump there, is faint, has nausea or sickness, ceases work at once, and has to be helped or carried home. The hernia is reducible with difficulty only, if at all, and is often strangulated. A medical man is at once consulted."

Sheen believes the sudden first appearance of a scrotal hernia to be impossible. He considers it highly probable that in all these sudden "first appearances" of hernia the individuals really had herniæ in infancy, the contents of which disappeared during the process of growth, such a condition more readily permitting a second entry, which may be sudden.

In this latter statement I do not entirely agree with Sheen, although I do believe that in practically all cases of inguinal hernia, except the direct, there is an open funicular pouch or process of peritoneum present at birth. In many cases this may not ever have had any contents in infancy, and, therefore, nothing more than a potential hernia was present, but later, through some extraordinary effort, something may be forced into this open pouch. These cases of sudden appearance of a hernia, however, are extremely rare, a very few such instances having been observed at the Hospital for Ruptured and Crippled in a series of nearly 90,000 cases.

Tillman goes so far as to say that "the supposed sudden development of a true hernia ia always due to a mistake in observation."

In conclusion, Sheen very aptly says: "A hernia may be felt for the first time during a straining effort, and this is very likely to occur in the working classes, who are constantly straining. This, however, is the occasion leading to the discovery of the hernia; it is not its cause."

That the accident or injury merely calls attention to a pre-existing hernia is shown by the statistics of Paul Berger,[1] who has made one of the most elaborate studies of hernia in connection with industrial accidents: 96 of 130 subjects who attributed their hernia to an accident, and whom he examined as medical expert, had multiple herniæ, presenting a total of 230 herniæ. In other words, 96 claimants had other herniæ, of the presence of which they were still ignorant.

The same fact has been frequently observed at the Hospital for Ruptured and Crippled.

It should be remembered that hernia in a normal individual, suffering from no organic disease of the heart and kidneys, is by no means a serious condition, but one that can be easily cured by an operation that is practically free from risk, and which will confine the patient to a hospital not more than two to three weeks.

Some reference should be made to *artificial hernia*, which is really a type of traumatic hernia, and which was produced by a special kind of "operators," practically confined to Russia, who produce herniæ upon persons who wish to avoid military duty.

Artificial hernia has recently been discussed by Krymow.[2] He believes the subject one of importance from three standpoints: social, medicolegal, and scientific, as the study of the methods employed for the production of artificial herniæ has an important bearing upon the etiology of inguinal hernia. Krymow, who has conducted a series of experiments upon the cadaver for the production of artificial herniæ, states that he succeeded in producing the same by tearing the aponeurosis and transversalis fascia. This procedure may be easy or difficult, acaccording to the size of the external ring and according to the strong or flabby condition of the transversalis fascia. In the cadaver a long continued pressure was sufficient to produce a hernia. He reports 5 cases of his own, 3 of which were artificial and 2 traumatic.

The Treatment of Hernia.—Umbilical Hernia.—The treatment of large irreducible umbilical hernia in stout women is a subject regarding which there is still wide difference of opinion. Operation in the majority of these cases is not an easy task and by no means free from risk. At the same time, one has to consider the probable outcome in these cases if left to themselves or treated by an abdominal belt. A considerable number finally come to strangulation, and operations for strangulation are attended with high mortality. In cases in which there has been a history of repeated obstruction bordering on incarceration, it is better to assume the risk of operation rather than wait until strangulation actually sets in. The later history of all these cases emphasizes the importance of early operation in all umbilical or ventral herniæ in the female. This does not include children, for the reason that the great

[1] Rev. Chir., April–May, 1906. [2] Arch. klin. Chir., vol. xci., Heft 3, 1910.

majority of umbilical herniæ in children are curable without operation.

As to the best type of operation for umbilical hernia, the Mayo operation already described (Vol. IV., p. 82) is, we believe, the best. It is very important in these cases to obtain primary union. For the deep sutures, the fascia and muscle, I always use chromicized kangaroo tendon, and believe that rarely, if ever, is it advisable to introduce the silver wire filigree, as advocated by a number of surgeons.

The after-history of umbilical and ventral hernia is well shown by a recent report of Denk's,[1] covering 165 cases observed at von Eiselsberg's clinic from April, 1901, to December, 1909, of which 135 were treated by operation; 14 per cent. of the cases, 18 umbilical and 1 epigastric hernia, were incarcerated. Of 89 umbilical herniæ, 41.6 per cent. were entirely irreducible.

The mortality of these cases was 4.4 per cent., *i. e.*, 4 deaths in 19 cases of incarcerated herniæ and 2 deaths in the 116 free herniæ.

Of 95 cases traced from one-half to eight and one-half years, 22 had a recurrence, while 72 were permanently cured. The cases in which suppuration occurred show 43.7 per cent. of relapses.

Direct Hernia.—An improved method of operating on direct hernia has recently been described by Wm. A. Downes, my associate at the Hospital for Ruptured and Crippled and the General Memorial Hospital. The essential features of the operation as he performed it in 50 cases are best stated in his own words: "As complete removal of the sac as conditions will allow; in many cases the sac is divided into two portions by the deep epigastric vessels, one part above and external, an indirect hernia, and another below and internal, the direct portion. In these cases the vessels should always be divided, thus forming one sac. As a matter of fact, all indirect herniæ should be explored by passing the finger through the neck and testing the condition of the posterior wall of the inguinal canal. Frequently a weakness will be found which was not suspected. A frank sac might not always be present, but it is in just such cases where there is a weakness that recurrence takes place, and in which the additional safeguard of transplantation of the rectus is indicated.

"After the sac has been disposed of, the internal oblique and transversalis are held up by a small, blunt retractor, placed at the internal ring, and these muscles are followed down and in until they join the transversalis fascia at the outer margin of the rectus. The sheath of the rectus formed by these structures at this point is opened and the muscle is exposed down to its pubic attachment. Three sutures of kangaroo tendon are now taken between the outer margin of the muscle and Poupart's ligament, which has been completely freed and exposed by proper retraction. The sutures should be placed from below upward and about $\frac{1}{2}$ to $\frac{3}{4}$ inch apart. A fourth suture may be necessary. After all sutures are placed, gentle traction should be made, drawing muscle and ligament well together, and while thus held by an assistant the sutures should be tied in the order of their insertion."

[1] Arch. klin. Chir., Bd. 93, Heft 3.

In his earlier cases Downes split the aponeurosis of the rectus on its upper surface, turned it down with the muscular fibers, and sutured it to Poupart's ligament, but in a number of instances the lower part of the muscle was found to be so thin that this incision went through, and when the sutures were tied a weak area, triangular in shape, was left in the muscle.

The retractor is now removed from beneath the internal oblique and transversalis muscles, and the usual Bassini operation performed from above downward, the sutures catching Poupart's ligament just superficial to and between those of the first row. The external oblique is then closed in the usual way. It is thus seen that there are three distinct layers, and not only the weak, but the often absent posterior wall of the inguinal canal has been strengthened as it could be done in no other way. The cord is always transplanted. If the cremaster muscle is so thin and frayed it had best be cut away; if, however, it is thick and

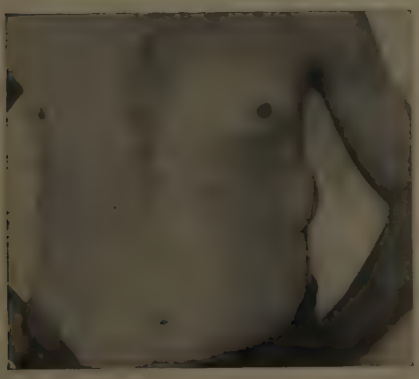

FIG. 297.—INTERCOSTAL DIAPHRAGMATIC HERNIA. (Gerster.)

FIG. 298.—INTERCOSTAL DIAPHRAGMATIC HERNIA. (Gerster.)

strong, it should be included in the sutures uniting the rectus with Poupart's ligament.

Downes states that all of his cases have healed by primary union, and thus far the results have been uniformly good. Ten have been traced for more than one year. One case was operated upon November, 1909, for double direct hernia. The patient's occupation is that of a prize-fighter, and he stated that he had felt like a new man since the operation. In this case the epigastric vessels were divided on both sides.

A very unusual case of **intercostal diaphragmatic hernia** has been recently reported by John C. A. Gerster, of New York.[1] It is evidently of traumatic origin, the patient having been hit on the left side of his chest by the end of a 1-inch plank about three years before. There was no hemoptysis nor disposition to vomit or other symptom. The swelling developed a few days after the accident, remaining nearly stationary in size. The accompanying illustrations (Figs. 297, 298) show very well the outline of the hernia.

[1] Annals of Surg., October, 1912.

PROPERTY OF

Gerster was able to add 4 cases to the 9 collected by Alquier in 1905–06, making a total of 13 cases.

The hernial opening in these cases may be as large as the tip of a finger or large enough to admit the entire hand. The herniæ vary from the size of a pea to that of an ostrich egg; a sac is usually absent.

Gerster believes the treatment should be mechanical or operative. If operation is done, the procedure should be varied according to the conditions found in the individual case. In some cases one is not able to make a layer suture of the diaphragm and the intercostal muscles; in others one has to approximate the ribs above and below, obliterating the space through which the hernia formerly protruded; in others still, a plastic closure may have to be resorted to.

Summing up, Gerster states: "Intercostal diaphragmatic herniæ are (1) usually of traumatic origin; (2) they occur mostly on the left side in the anterior portion of the intercostal spaces (sixth to tenth inclusive), a region lying between the lower margin of the lung and the free border of the rib from the midline to the midaxillary line; (3) their symptoms are those common to herniæ in general; (4) the *x*-ray is of great value in determining the relationship of the various parts of the alimentary canal to the herniæ; (5) the details of operative treatment vary with the finding in individual cases."

The Injection Treatment of Hernia.—I made no mention of this method of treatment in my former chapter for the reason that I believed it had no place in the modern treatment of hernia, but perhaps it deserves brief mention, if for no other reason than to point out its demerits.

It is still strongly advocated by certain men, and receives its chief support from those who have a strong prejudice against operation. Various substances have been put forth from time to time as the best material for the injection treatment of hernia, *e. g.*, oak bark, alcohol injections, and, of late, paraffin. In a book recently written on "Paraffin in Hernia" it is stated that "paraffin has a tendency to promote the formation of connective tissue, and in hernial cases there is invariably a state of the parts which will be benefited by the throwing out of connective tissue in the neighborhood of the deficiency which gives passage to the hernial contents."

The advantages of this method, as stated by the author of the book, are that "the injection treatment is far simpler than the open operation, and can be accomplished in two to four minutes, whereas the open operation cannot be performed without the aid of several trained assistants and without elaborate and extensive preparation." It is further stated that "hospital surgeons may be expected to condemn the injection treatment of hernia, as it will open to thousands of the profession a field which has hitherto been monopolized by the surgeons with hospital facilities"—a statement which will hardly apply to those members of the profession with whom the welfare of their patients is of higher moment than personal considerations.

It is stated that the paraffin injection may be followed by consid-

erable pain for a day or two, and codein is advised in ½-gr. doses every hour while the patient is suffering actual pain.

Only 10 cases are cited in proof of the value of the operation, and in all but 2 the later history is lacking, and in only 1 case was examination made more than a year after treatment. In most of the cases the hernia was very small and reducible; in fact, the author of the work states that large herniæ that have gone unreduced for years have not been treated by injection, and discretion demands that for some time or until injection treatments have been practised upon many patients, large ruptures be left to the surgeon or be injected only by practitioners capable of doing the cutting operation in the advent of the failure of the injection treatment. He further states that for his own part he "has felt no hesitancy in injecting cases which promised a fair degree of success, realizing full well that untoward symptoms of a local character may be overcome by free dissection, removal of the paraffin, and restoration of the inguinal canal by the usual surgical means."

While I have had no personal experience with the injection treatment of hernia, I have observed a sufficient number of cases treated by injection by other men to justify me in strongly condemning the method. In the first place, it is based on the now well-established error that cicatricial tissue furnishes a permanent barrier to any opening in the abdominal wall. Temporarily, while the new connective tissue is constantly being formed, it is easy to understand how a small hernial opening may be sufficiently closed to prevent the escape of a hernia. Later on, this same cicatricial tissue tends either to be absorbed or to stretch indefinitely, and, hence, it cannot in any way effect a lasting cure. The alternative set forth that in case of failure to cure the rupture by the injection method it can be just as well operated upon by the open method, is certainly based upon theory rather than practice. I have operated upon a number of cases of this nature, and I found them the most difficult operations in surgery, by reason of the extensive adhesions always present. Those who advocate the injection methods do not attempt to cure the more difficult cases, but only the small and easily reducible ones that can be easily and permanently cured by an operation lasting not more than ten to fifteen minutes, and confining the patient to bed but a few days longer than the injection method, and, furthermore, attended with much less risk.

I have seen serious accidents happen from the injection method, in which some of the fluid entered the sac and found its way to the free abdominal cavity, causing extensive adhesions resulting in intestinal obstruction. I regard the injection treatment as far more dangerous than the open method of operation, while offering little or no chance of a radical cure.

CHAPTER CXXVIII.

SURGERY OF THE LIVER, THE GALL-BLADDER, AND THE BILIARY DUCTS.[1]

By William J. Mayo, M.D.,

Rochester, Minn.

GALL-STONES.

Gall-stones are foreign bodies, and, other things being equal, they should be removed before infection and other complications occur which increase the risks of operation and diminish the chances of a permanent cure for the patient.

In reviewing operations performed in St. Mary's Hospital[2] upon the gall-bladder and biliary passages we have been impressed with the fact that the mortality was due to the complications incident to the disease rather than to the removal of gall-stones from otherwise normal gall-bladders. Not only is the mortality greatly increased by the involvement of the deep bile-passages, the liver, pancreas, and neighboring viscera, but the gall-bladder may also be found in such a condition as to render an attempt to save it impracticable, and fraught with a possibility of a recurrence of symptoms. The gall-stones are, however, the responsible agents in the production of these complications, inasmuch as they set in motion a train of events which would not have occurred had the gall-stones been removed early in the history of the disease.

In simple cholelithiasis the calculi are found free in the cavity of the gall-bladder. As a rule, the bile enters and leaves the gall-bladder without hindrance, and the colic is merely a painful manifestation of temporary obstruction; an acute blockage mechanically brought about by the gall-stones or by coincident infection, which, for the time being, converts the gall-bladder into a closed cavity. The patient has the typical "gastralgia" of the ancients, a pain which is referred to the epigastric region, extending upward behind the sternum through to the back, sometimes to the right, less often to the left, lasting from a few minutes to six or eight hours, and there may be complete freedom from all symptoms between attacks. There is very little constitutional disturbance in the *colic* stage of gall-stone disease. The gall-bladder has no lymphatic glands, but few lymphatic channels, and its cavity distends so readily that the infectious contents are not subjected to great tension, therefore the absorption of toxins is minimized, the pulse and

[1] Supplementary to Chapter L., Vol., III. p. 966.
[2] Canadian Medical Association Journal, September, 1911.

temperature remain normal, and local symptoms, such as tenderness or pain in the region of the gall-bladder, as a rule, are absent.

In the early period of the disease operation furnishes an easy, safe, and effectual cure. *Cholecystostomy*, with temporary drainage of the gall-bladder to the surface, is the operation preferred because it saves this valuable organ for future function. As a rule, the patients are up and about in from eight to ten days, and in from twelve to fourteen days they leave the hospital with healed wounds.

The danger of re-formation of gall-stones after cholecystostomy is exceedingly small. In our series we observed but 3 cases in which stones had re-formed in the gall-bladder, and it is probable that in the majority of cases of supposed re-formation of gall-stones the stones had not re-formed, but were not all removed at the primary operation; an accident which does not often happen when the operation is done early.

The function of the gall-bladder is probably to take the tension from the common and hepatic ducts and the ducts of the pancreas. It also acts to produce mucus, which protective substance, when mixed with the bile, tends still further to reduce the chances of pancreatic and other complications. The hypothesis that the function of the gall-bladder is that of bile storage is obviously erroneous, since there are from 30 to 50 ounces of bile secreted each day, and the capacity of the normal gall-bladder is but 1 ounce, a quantity relatively too small to be of much importance; and, for that matter, there is not sufficient muscular tissue in the gall-bladder to enable it to contract for the purpose of emptying its cavity, as do organs of storage function, for example, the stomach and urinary bladder.

Continued obstruction marks the second stage of gall-stone disease. The gall-bladder does not regain cystic-duct drainage, but remains a closed cavity, and the patient, instead of obtaining relief in a few hours, has a continuance of symptoms for a greater or less length of time, leading finally to cystic gall-bladder, empyema, etc. During this stage an elevation in temperature takes place, usually 100° to 102° F., and for the first time we find tenderness in the region of the gall-bladder, which may often be palpated as a tumor. So serious is the effect produced by the lack of drainage and the infection that the function of the gall-bladder may be permanently destroyed. If the infection is acute, perforation into the free peritoneal cavity may occur, or more often by ulceration into the duodenum, transverse colon, or the stomach, discharging the stones and infective material through the fistulous opening, leaving behind a permanent crippling of the involved organs. Sometimes the gall-bladder perforates posteriorly into the liver, forming secondary abscesses, or it may perforate into a peritoneal pocket which becomes attached to the abdominal wall by advancing protective peritonitis, and after prolonged invalidism of the patient opens spontaneously on the surface of the body.

In the majority of cases of continued obstruction, however, the fluids are absorbed slowly, the gall-bladder contracts upon the mass of stones, which then remain as a source of chronic irritation and the

cause of recurrent regional peritonitis, or the local symptoms disappear and the patient develops a chronic gastric trouble which is usually called dyspepsia or indigestion, and is unavailingly treated for years for supposed disease of the stomach, when the stomach is merely acting as a mouth-piece to call attention to the disturbance elsewhere in the digestive tract. Treatment directed to the stomach in these cases is about as effectual as it would be to deluge with water a fire-alarm box because it is sounding the alarm of fire.

For **operations upon the gall-bladder and ducts** an abdominal incision about 4 inches in length should be made through the outer third of the rectus muscle. This incision facilitates general exploration with the gloved hand. This should be a routine practice, done thoroughly, including all of the abdominal viscera, with special reference to those organs which may harbor diseases giving rise to a similar symptomatology. More than one organ in the abdomen will be found diseased in a considerable percentage of cases, though not always to such an extent as to require simultaneous operation. Information gained in this way may be of the greatest value to the patient. The discovery of small fibroids of the uterus in the female, perhaps symptomless at the time of examination, may furnish an adequate explanation of certain symptoms occurring at some future time. Small dermoid cysts of the ovary with a long pedicle frequently give rise to symptoms which may be mistaken for gall-stone disease. The appendix may be found abnormal in about one-half of the cases, possibly not to such an extent as to require independent operation, but more than enough to justify the slight risk of its coincident removal. Stones or other abnormal conditions in the kidney or ureter may be brought to light. An ulcer of the stomach can usually be discovered without difficulty by the sense of touch. This, however, is not always true of the duodenum, and the aid of the sense of sight should also be invoked. The spleen will seldom be involved, but should be palpated. Merely passing the hand over the intestinal tract will occasionally reveal some unexpected condition. This general examination with the gloved hand will not occupy more than a minute; it is quite free from danger, and a number of diagnostic oversights and undersights may be brought to light by the surgeon who is accustomed to making such examinations. A sense of *visceral* touch peculiar to the abdominal region can be acquired, which is as necessary of cultivation as is the examination of the pelvis through the vagina and rectum.

After completing the general abdominal examination one comes to the special examination of the organs supposed to be involved. The pancreas should be examined first, then the liver, ducts, gall-bladder, etc., in this way narrowing the field down to the seat of operation. If one examines the gall-baldder region first and finds stones, the general examination may be perfunctory. If the gall-bladder is operated on before the general examination of the abdomen is made, the danger of carrying infection will be incurred.

The common duct should be examined both before and after empty-

ing the gall-bladder. Occasionally stones in the common duct will be found more easily before, sometimes after, emptying the gall-bladder. In all cases in which there has been a history of colic, chills, fever, loss of flesh, etc., the common duct should be exposed and inspected. If it is distended and thickened or has any other evidences of disease it should be opened and explored. Stones overlooked in the common duct are the most frequent cause of symptoms recurring after gall-stone operations. To thoroughly examine the common duct the abdominal incision should be enlarged after the plan of Bevan, *i. e.*, continuing from the upper angle toward the median line along the costal border. This can be accomplished by division of the skin and aponeurotic structures and retraction of the muscles. In the male the chest wall is often more barrel shaped than in the female, and the liver may be thicker and extend farther to the right, so that the gall-bladder, lying to the outside, is not easily accessible, through the straight incision; if so, the complete Bevan incision, *i. e.*, dividing the aponeurosis outward from the lower angle of the abdominal incision as well as inward from the upper angle and retracting the muscles, is the most satisfactory procedure.

Cholecystostomy is the best operation to perform upon the gall-bladder and should be the operation of choice, especially if there be jaundice or disease of the common duct and pancreas, unless there are direct indications for cholecystectomy. One of the most distressing sequelæ of cholecystectomy are those fibrous changes in the ducts of the liver or pancreas which result in chronic jaundice of a permanent character. The accidental division of the common duct has often occurred in the course of cholecystectomy, but such accidental division may be rectified at the time if it is discovered, or, secondarily, by the union of the hepatic duct to the duodenum.

Partial cholecystectomy can often be practised with great benefit, since, on account of its limited blood-supply, the fundus of the gall-bladder is more often severely affected through infection. Gangrenous spots can also be found. It is an easy matter to trim away the fundus, saving the lower half of the gall-bladder for drainage purposes, and should future trouble occur in the common duct or pancreas requiring secondary operation the part retained may serve a very useful purpose.

In comparing cholecystostomy with cholecystectomy it should be noted that cholecystectomy has a slightly higher mortality, and that this increased death-rate does not depend upon causes which can be eliminated, but rather which are inherent to the operation itself. In our experience the ultimate results for the patient following cholecystectomy have been no better than in cholecystostomy under similar conditions.

The question of removing the gall-bladder in acute infections is open to doubt. As pointed out by Summers, cholecystostomy gives equally good results with a smaller immediate mortality, even though later it may be occasionally necessary to remove a stone which was

overlooked at the primary operation. As a rule, however, all of the stones can be removed in acute as well as chronic conditions by cholecystostomy or *partial* cholecystectomy.

In performing cholecystostomy, if there should be thin, stinking bile, containing colon bacteria in the cavity of the gall-bladder, it will be wise to suture the gall-bladder to the aponeurosis and not turn in its peritoneal margins, since re-infections sometimes occur after a few weeks, causing the necessity for a secondary operation, or the patient may develop a severe illness for a number of days, with deep-seated pain and tenderness in the region of the gall-bladder, attended with temperature and jaundice, until an abscess appears in the line of the former incision, through which will be evacuated pus and bile. By anchoring the gall-bladder to the aponeurosis, should reinfection follow, the pus and bile will readily find its way to the surface and the patient will be saved a great deal of subsequent trouble.

FIG. 299.—A ¼-INCH RUBBER DRAINAGE-TUBE AND RUBBER TISSUE READY TO BE ROLLED FOR GALL-BLADDER DRAIN.

Suppurative conditions of the gall-bladder and ducts demand, as a rule, both tube and gauze drainage *inside* the gall-bladder, and *outside* a large split-rubber tube should be drawn over the gall-bladder, the *split* in the tube being placed toward the liver to prevent the intestine from becoming adherent. For ordinary cholecystostomy we prefer the tube drainage, which we have used for years. A rubber tube ¼ inch in diameter is wound with a strip of iodoform gauze and outside of this some rubber tissue is placed (Figs. 299, 300). The packing outside the tube enables the margins of the gall-bladder to come in close contact with the tube without danger of kinking it or permitting leakage. After the peritoneal margins of the gall-bladder are well turned in a final suture is placed, uniting the gall-bladder to the tube. It is not essential that the gall-bladder be attached to the peritoneum, however, if it is long enough, we usually suspend with a suture to the

upper angle of the incision. A thick-walled red rubber tube may be used in place of the dressed tube just mentioned; it answers the purpose quite as well. If there is no leakage about the tube and if the drainage is adequate it makes little or no difference what method is used in draining the gall-bladder.

Cholecystectomy is indicated when there has been a degree of injury to the cystic duct sufficient to interfere with free drainage between the gall-bladder and the common duct. Small stones impacted in the cystic duct are perhaps the most frequent indication for cholecystectomy, but if the common duct or pancreas are diseased it is better practice to remove the stone from the cystic duct by direct incision down upon it, suturing the opening with fine catgut, than it is to remove the gall-bladder.

For cholecystectomy a free abdominal incision of the Bevan type, dislocating the liver downward and outward, using the gall-bladder as a tractor after the Robson method, will best expose the ducts. The cystic duct should be carefully exposed, double clamped, and cut between. Failure carefully to expose the cystic duct has often caused injury to the common duct. This procedure exposes the cystic artery, which is also clamped. An incision through the peritoneum along either side of the gall-bladder facilitates its ready separation from the liver. After dissecting the lower half of the gall-bladder free the cystic duct and artery should be tied with catgut. It may be difficult to accomplish the necessary exposure if the gall-bladder be completely removed. If the surgeon is not quite positive as regards the condition of the common duct and pancreas, provision should be made for drainage of bile in case of necessity by leaving the clamp on the cystic duct so that it can be unlocked and removed in from twenty-four to forty-eight hours, or the catgut ligature on the cystic duct may be left long, so that it can be pulled away at any time, leaving the duct open. On several occasions we have seen a patient in a serious condition after cholecystectomy relieved by loosening up the stump of the cystic duct, thus allowing a sudden escape of pent-up bile. It is sometimes wise to leave the cystic duct open after cholecystectomy, and by means of tubes furnish adequate drainage to the surface.

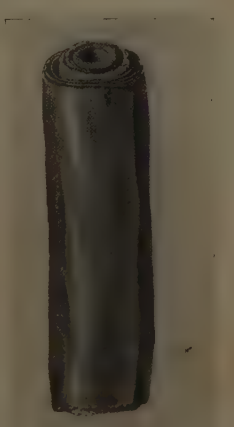

Fig. 300.—Gall-bladder Drain Complete.

Removing the gall-bladder will occasionally be followed by a disagreeable oozing of blood from the gall-bladder notch of the liver, which may be checked by properly placed catgut sutures. It is sometimes difficult to place these sutures accurately, and in such cases gauze packing will be necessary. The action of the diaphragm may displace the gauze pack downward, leaving a suction cavity, so that the pack, instead of actually checking the bleeding, may have little effect upon

it. In such cases a clamp-forceps should be placed on the cystic duct and several strips of weak iodoform gauze placed in the notch of the liver, the handles of the forceps brought out through the wound, and the forceps and gauze enclosed outside by a piece of large split-rubber tube. The abdominal wound is then sutured in such a manner that the forceps are carried to the upper angle, giving two fixed points, one at the cystic duct and the other on the suture line of the abdominal incision, the weight of the liver compressing the oozing surface against the gauze and the forceps. In fleshy people, where dislocation of the liver downward and outward is difficult and a long incision may be followed by a hernia, forceps may be applied to the cystic duct and artery without ligature and protected by a split-rubber tube. The forceps should be removed in from forty-eight to seventy-two hours.

In some forms of cholecystitis without stones, especially the type known as "strawberry gall-bladder" (Plate VIII.), cholecystectomy is demanded. All thick-walled, functionless gall-bladders should be removed, since they are not only useless, but a menace of carcinoma.

Choledochotomy is not a serious operation of itself. In uncomplicated cases the death-rate is less than 2 per cent. It is in the long-standing cases with chronic jaundice and degenerative changes in the kidney and cardiovascular system in which the greatest mortality is found. Here, again, free and adequate drainage of bile to the surface is the *sine qua non* of success. This fact was first recognized by the late W. R. B. Davis. The so-called hepaticus drainage of Kehr has reduced the mortality more than 50 per cent. following common duct operations.

Upon locating stones in the common duct one of the stones should be worked into that portion of the duct which lies between the common duct and the duodenum. Holding the stone between the thumb and finger of the left hand, the adhesions are carefully separated with a pair of forceps until the wall of the common duct is seen. An incision not quite large enough to remove the stone is made longitudinally into the duct, and the margins of the incision grasped with a forceps. The gauze protection is rearranged and the incision enlarged until the stone can be slipped out. With the stone will come a considerable quantity of infected bile, which is sopped out and the remaining stones removed with a scoop. The Robson rigid scoop and the Finney scoop with the malleable shank are the most useful for this purpose. Stones in the common duct do not always give an appreciable "feel" to the scoop, and it is very difficult to tell when the duct is empty, therefore, whenever it is sufficiently dilated, the finger should be introduced to explore its cavity, and, finally, malleable common duct probes should be passed down through the duct into the duodenum to make sure that no stricture or other obstruction exists. Since practising this manuver we have not found secondary stones or stricutes in the common duct, which occurred in 2 of our early cases.

Occasionally it will be difficult to remove stones from the hepatic duct. By using the finger in such a way that it will act like the piston

PLATE VIII.

CHOLECYSTITIS CATARRHALIS CHRONICA. (MACCARTY.)
A color photograph showing the fresh appearance of the "strawberry" gall-bladder.

of a syringe, a suction can be produced which will often cause the stone to come down to a point where it can be removed. Impacted stones in the ampulla or papilla can usually be manipulated into the middle portion of the common duct for removal. The easiest method of accomplishing this procedure is to introduce the forefinger of the left hand into the common duct until the tip rests against the stone. With the fingers and thumb of the right hand the stone is worked back against the dilating finger until it can be removed. Occasionally it will be so tightly impacted that it will be necessary to open the duodenum so that the stone may be removed by incision of the papilla on the mucous surface. It will not be necessary to suture the incision in the posterior wall of the duodenum. The incision in the anterior wall of the duodenum should, of course, be sutured in the ordinary way. We have had a number of cases in which it was necessary to remove the stone by the transduodenal method of McBurney, always with favorable results.

Drainage of the common duct is best accomplished by passing an English catheter with the end cut off (Figs. 301, 302), and a lateral eye about 1 inch below the cut end for side drainage. The catheter should be passed into the main hepatic duct in such a manner that it shall project up into the right hepatic duct, which is continuous with the main hepatic and common ducts. The eye should be turned toward and placed in front of the left hepatic duct. The catheter is then sutured to the upper angle in the incision in the common duct with a fine catgut suture; the *holding* catgut suture should be placed in the catheter with the ends left long before introducing the catheter into the hepatic duct. By threading each end of the suture into a needle after the catheter is in position it is readily held in place within the duct by passing the threaded needles from within out on each side and tying. The catgut will be absorbed before it is necessary to remove the catheter. The duct is closed about the catheter and the neighboring peritoneum is drawn over the suture line. The size of the catheter used should be in proportion to the size of the duct. A large split-rubber drain is placed about the catheter (Figs. 303, 304). The right side of this drain is left 1 inch longer (Fig. 304), so that the longer end will project down into the Morison pouch in front of the right kidney.

In patients very sick from cholangitis, a free discharge of bile to the surface is essential. In such cases the common duct should be opened without regard to whether or not it contains stones. The most common cause of death following operations upon the gall-bladder and bile tract is failure to secure free drainage of bile to the surface.

Cholecystoduodenostomy is an operation which has a considerable field of usefulness. At the present time we practically always make the union between the duodenum and the gall-bladder rather than between the stomach and jejunum or between the colon and gall-bladder. As a rule, even when the duodenum is deeply placed and fixed it can be sufficiently cleared so that the fundus of the gall-bladder can be drawn down and united to it by sutures. It is not at all necessary to loosen up the duodenum so that clamps can be used. The gall-bladder should

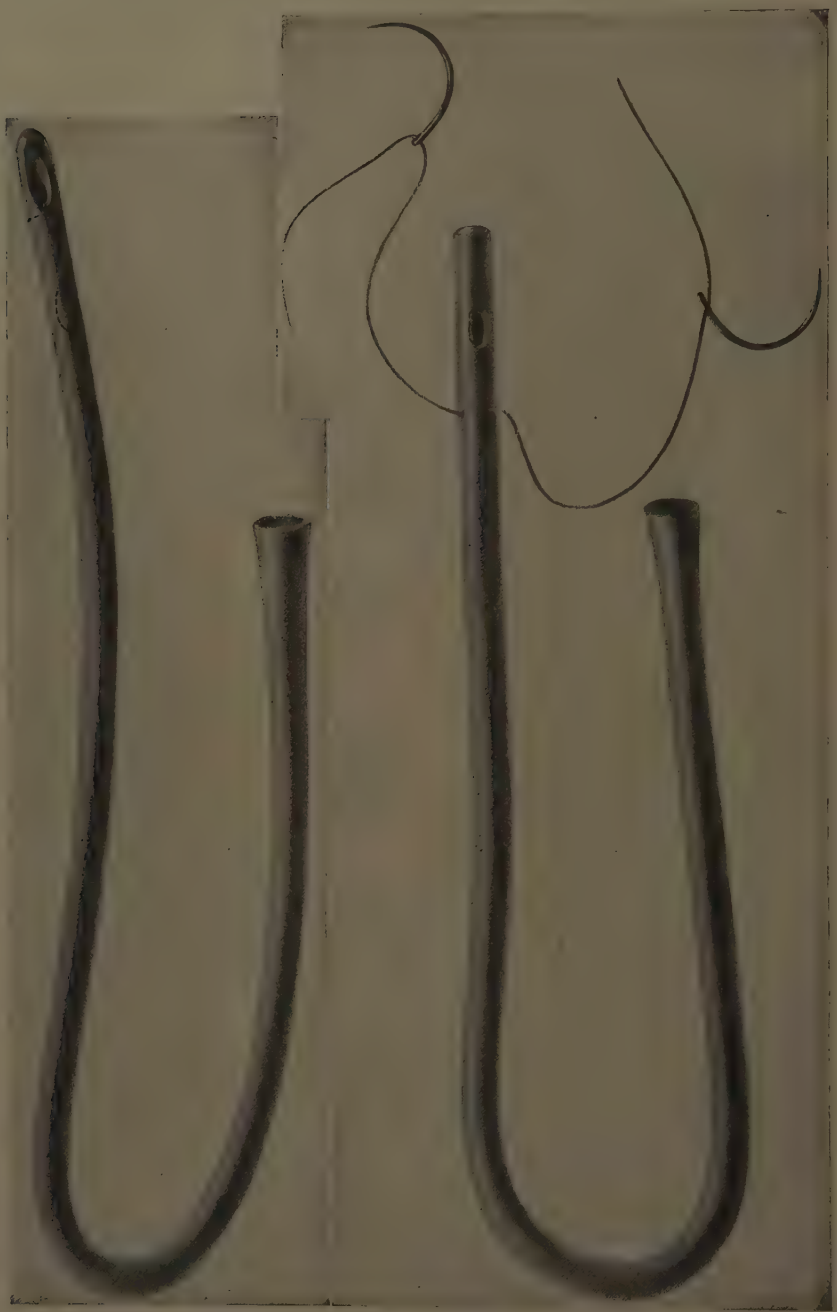

FIG. 301.—CATHETER. Dotted line shows proposed site of openings.

FIG. 302.—CATHETER PREPARED FOR COMMON DUCT DRAINAGE.

be opened and its contents emptied. The contents of the fasting stomach and upper duodenum are nearly sterile, and by placing small gauze packs behind and around the operative field the escape of bile and duodenal secretions does not apparently exert a deleterious influence. A union ¾ inch in length is made between the duodenum and gall-bladder by applying two rows of sutures of fine linen with a small curved needle. When the operation is completed a small portion of the adjacent omentum is drawn up and attached with one or two catgut sutures, as an additional protection. One or two layers of folded rubber tissue are introduced as drains, a precaution which has not proved necessary in our experience, since in a considerable number of cases we have never had leakage or infection.

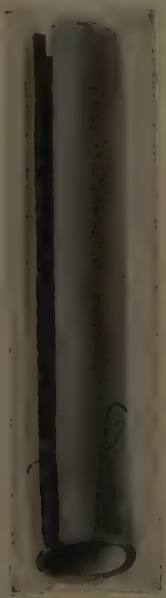

FIG. 303.—SPLIT-RUBBER TUBE. Dotted lines showing where it is to be cut.

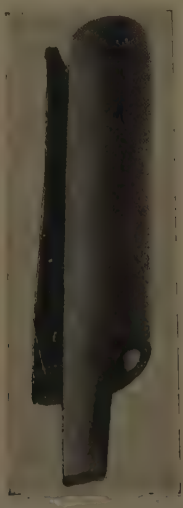

FIG. 304.—SPLIT-RUBBER TUBE PREPARED FOR DRAINAGE OUTSIDE OF GALL-BLADDER AND DUCTS.

After-treatment.—The after-treatment of the average case of cholecystostomy for gall-stones is simple. The drainage-tube should be removed on the seventh or eighth day. At this time the bile is usually sterile, thin in character, and light yellow in color. If drainage be continued for a longer time there is danger of reinfection; the bile becomes dark green in color, and, instead of a quick closure, the drainage will be continued from the fistula for two or three weeks. In our experience long-continued drainage has not been necessary, unless to meet some special indication.

The after-treatment of cholecystectomy is equally simple, the drains are removed from the sixth to the eighth day, and the drainage tract filled with sterile oil or vaselin.

In common duct cases all the drains excepting the catheter should be out at the end of the first week, the split tube on the fourth or fifth day,

the gall-bladder drain on the seventh day. The catheter should be left in the common duct until about the ninth or tenth day, usually about two days after the removal of the last of the other drainage-tubes. In debilitated cases, after operations for common duct stone, saline proctoclysis by the Murphy method is essential and should begin immediately after operation. From 4 to 6 quarts should be given in the first twenty-four hours; at the end of that time the patient will usually be able to take plenty of water by the stomach. Fluids given by rectum are picked up by the portal circulation and serve to flush the liver, causing large quantities of bile to be secreted in the first twenty-four hours. Some patients do not retain saline solution given by the rectum. In such cases it can be given slowly through the drainage-tube, either through the gall-bladder tube or the common duct tube, after the method of McArthur. We have often given several quarts in this way during twenty-four hours, but, as a rule, not beginning until twenty-four to forty-eight hours after the operation, to insure sufficient adhesion to prevent leakage into the free peritoneal cavity.

After operations upon the gall-bladder and ducts the patient should be carefully watched, and if there be any evidence of retention of fluids in the stomach, it should be washed out. This procedure is most important and should be repeated sufficiently often to keep the stomach empty.

If there be obstructive jaundice from stones in the duct, especially in the acute stage, one should not, as a rule, operate. We usually wait until the icterus becomes chronic or until some bile appears in the stool. We have not found the internal administration of calcium chlorid of any particular value in checking the tendency to hemorrhage in such cases. Our experience with horse, rabbit, and human serum, or blood transfusion has been insufficient to enable us to judge of their merits as preventives of the hemorrhagic tendency in the icteric. We have seldom seen patients with jaundice due to gall-stones die from hemorrhage; patients who have died from postoperative hemorrhage have nearly always shown malignant disease as a complication at postmortem. The coagulation time of the blood is of some value in indicating whether or not the patient is liable to bleed, but it must not be forgotten that the coagulation of the blood is not the only factor; the condition of the patient's blood-vessels is of importance, and this cannot be foretold with accuracy.

CHAPTER CXXIX.

SURGERY OF THE PANCREAS.*

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ACUTE PANCREATITIS.

Although the frequency with which cases of pancreatitis have been reported in the literature has greatly increased during the last two or three years, yet the case reports show how relatively uncommon it is for a true diagnosis to be made before operation. Happily the need for immediate operation is generally recognized, even though the exact nature of the trouble be in doubt, and this is a great step in the right direction.

In the presence of so grave an abdominal condition it is evident that the surgeon will not often be able to obtain any detailed account of the patient's previous history. Still, in many reported cases, there is a story of former attacks of colic or vomiting and pain; these are generally attributed to cholelithiasis, but this experience does not always hold good, for in certain cases the gall-bladder and bile-ducts show no evidence of disease at the time of operation. In such cases it is reasonable to consider the previous attacks as pancreatic in origin.

As regards the etiology of acute pancreatitis, a study of reported cases and experimental work goes to confirm our previous conceptions of the importance of infection of the gland through its excretory duct. This infection, or entry of intestinal juice into the ducts of the pancreas, activates the pancreatic juice and leads to autolysis of the cells and gangrene or hemorrhage (Coenen).[4]

In the present state of our knowledge, it is idle to consider hemorrhagic, gangrenous, or suppurative pancreatitis as separate affections; we should rather look upon acute pancreatitis as a disease, which, if not rapidly fatal, leads to gangrene and suppuration, the severity of the onset (acute hemorrhagic necrosis) and the extent of the subsequent changes being dependant on the intensity of the causative factor. According to Opie and Meakins,[21] hemorrhagic pancreatitis is primarily a necrosis of parenchyma, the inflammatory changes being secondary to necrosis or infection. Gangrenous pancreatitis is a late stage of hemorrhagic necrosis.

The most characteristic feature of the onset of acute pancreatitis is the sudden severity of the symptoms. Agonizing epigastric pain,

* Supplementary to Chapter LI., Vol. III., p. 1035.

early and persistent vomiting, collapse, and a rapid rising pulse-rate are the most constant features.

In addition to these, persistent and uncontrollable belching and hiccup are mentioned by Deaver[7] and Cheney.[3] In 8 out of Musser's[19] 9 cases, dyspnea was a very striking symptom. This writer also mentions an acute anemia of a secondary type, while Dreesmann[8] speaks of a characteristic grayish complexion, which he attributes to the loss or destruction of blood.

Gobiet[10] has called attention to the isolated distention of the transverse colon as an early sign of considerable value; it is also noted by Albrecht,[1] Robertson,[25] and Deaver.[7] This is explained on an anatomic basis by assuming that the peripancreatic effusion infiltrates the base of the transverse mesocolon and injures the nerves lying between its folds.

If the patient survives the shock of the initial symptoms, other signs appear, of which the most important are the strikingly rapid emaciation and the development of an abdominal swelling.

Michel[18] lays stress on the diagnostic value of this epigastric tumor. At first a pancreatic swelling even of considerable size will be resonant on account of the overlying stomach and colon. As the swelling enlarges, it either pushes the stomach down, causing an area of dulness above it, or it pushes its way between the stomach and colon. By injecting the lesser sac in the cadaver, Michel was able to show that the resulting tumor always occupied the left hypochondrium, encroaching a little on the right, but never passing beyond a line through the sternal articulation of the tenth rib.

In the acute forms of pancreatitis the matter is so urgent and time so precious that the various laboratory aids to diagnosis will rarely be available. The surgeon will have to make a prompt decision, based on clinical signs alone, for or against operation.

In the **treatment** of acute pancreatitis there is some difference of opinion as to whether immediate operation is desirable or not. The slighter cases of acute pancreatitis do not, according to Ochsner,[20] require operation. Deaver[7] holds that, while in cases becoming rapidly and progressively worse operation may be imperative, it should not be undertaken in the state of primary shock following the onset of the distinctive symptoms of pancreatitis. Körte[14] is decidedly in favor of early operation; he believes that one should endeavor to operate before the appearance of gangrene to procure an outlet for the secretions and to put a stop to the advance of the necrosis if possible. Of 16 cases operated on within the first two weeks, 11 recovered; of 14 operated on in the third and fourth weeks, 7 died; while those operated on in the fifth to the seventh weeks, all died.

In 21 operations suppuration and inflammation were found, but no necrosis was present; of these, 16 recovered and 5 died. On the other hand, there were only 2 recoveries out of 13 cases where the operation showed extensive necrosis of the pancreas.

Körte looks upon necrosis of the pancreas as secondary to inflamma-

tion or to a primary hemorrhage, and he points out that this necrosis may occur very early—in 1 case on the fourth day. These cases of early necrosis have a very bad prognosis.

In considering the indications for immediate operation, the difficulty of diagnosis should be remembered. In a large proportion of cases no exact diagnosis is arrived at, or the perforation of one of the viscera, stomach, duodenum, gall-bladder, or appendix, is suspected. In such as these most surgeons would advise immediate operation. Also, as Battle[2] has pointed out, immediate laparotomy is justified for the sole purpose of relieving the intense pain.

If early operation is decided upon, a median abdominal incision is the method of choice. If the diagnosis was before in doubt, the presence of areas of fat necrosis, when present, and a bloody serous exudate will now lead one in the right direction. Ransohoff[23] records 3 cases of "ultra-acute" pancreatitis, in which the effusion of blood with clots was very noticeable, in 1 being so profuse as to suggest the rupture of an aneurysm. In only 1 of his cases was fat necrosis present (about twenty-four hours from the beginning of the attack).

Most surgeons agree that the peritoneal exudate should be mopped out, the pancreas itself exposed through the gastrocolic omentum, and incisions made into the substance of the gland to allow of a free escape of the inflammatory exudate, which is to be conducted to the surface by means of rubber tubes protected by gauze packing. Battle,[2] however, thinks that better results will be obtained on the average from simple drainage of the peritoneum than from more elaborate operations, such as incision of the gland, etc., though he admits that incision of the pancreas and drainage is the ideal. Körte says that it is essential in all operations for acute pancreatitis to avoid all unnecessary searching among the distended loops of intestine; the sooner the inflamed pancreas is recognized and laid open the better are the prospects of success. This need for care is also emphasized by Ochsner, who advises limiting the operation to drainage of areas of infection and necrosis, to the control of hemorrhage, and drainage of the entire area. If jaundice is present, simple drainage of the gall-bladder, with the removal of loose stones, is indicated, but it is better not to interfere with stones impacted in the ducts.

It is true that in several cases recovery has ensued though the pancreas has not been exposed at the operation. Albrecht records a recovery after simply introducing a tube into the distended transverse colon, and Tietze[31] one after cecostomy and another after entero-anastomosis; both of his patients showed fat necrosis.

In the later stages of the disease, when peripancreatic suppuration has occurred, and tends to spread toward the left, a left lumbar incision is preferred by Deaver and Körte. This allows of dependent drainage and avoids the risk of infecting the peritoneal cavity.

In the subsequent progress of these cases, Körte calls attention to the occurrence of severe hemorrhage from the wound from one to five weeks after the operation. This rapidly led to death in 6 of his cases.

CHRONIC PANCREATITIS.

It is in this affection that the various functional and laboratory tests have their chief value. Around this subject a voluminous literature has accumulated during the past few years, dealing more especially with Cammidge's reaction.

Schwartz,[27] reporting from Eiselsberg's clinic, is impressed with the value of these tests (Sahli's glutoid capsule, Schlecht's trypsin test, etc.), especially Cammidge's reaction, which was confirmed by the ultimate course of the cases. Kehr[12] places great reliance on Cammidge's reaction; in fact, he regards a positive reaction after four weeks' medical treatment as an indication for operation in the "latent" stage of gallstones. Deaver[7a] found the Cammidge reaction positive in 4 out of 19 cases. Roughly speaking, in all the cases in which the condition of the pancreas was determined accurately at the time of operation, the Cammidge reaction was positive only about two and a half times as frequently when the pancreas was affected as when it was not.

Sailer's[26] experience leads him to think that Loewy's test (mydriasis after instillation of adrenalin) is extremely doubtful; examination of the duodenal contents (after administration of oil) is difficult and at present not sufficiently conclusive; the test for trypsin in the feces (Müller-Schlecht) is simple, but the results vary; as to Sahli's capsules, no definite conclusions can be drawn, either from a positive or negative result, and the same applies to the nuclei test of Schmidt. Pilcher,[22] in a careful study of the question in Mayo's clinic, concludes that a typically positive reaction, with a negative control, is almost pathogenic of pancreatic derangement; the converse is not shown.

These findings of Pilcher led to further investigations in the pathologic department of St. Mary's Hospital (Mayo clinic) under the direction of Wilson.[33] In this study the personal equation of the investigator was eliminated by having the end reactions classified by one who knew nothing of the patient. Working on these lines, and following Cammidge's technic, he examined 26 cases of pancreatitis, of which 35 per cent. were positive. Among 74 patients who were known to have no pancreatic disease, but were suffering from some other abdominal or pelvic lesion, 47 per cent. gave positive reactions. There were 207 patients who in all probability had no pancreatitis; among these 35 per cent. were found to give a positive reaction. Of 17 healthy individuals, 30 per cent. were positive.

Wilson concludes that if knowledge of the clinical histories and other factors of the personal equation be eliminated, the results, as a means of diagnosing pancreatic disease, are both valueless and misleading.

Kinnicutt's[13] conclusions, that the reaction is not pathognomonic, but is strongly suggestive of inflammatory and destructive lesions of the pancreas, appear to express very fairly the general opinion on this matter.

The leading and most constant symptom, according to Deaver,[7a] is pain, which was absent in only 3 out of 38 cases of chronic pancreatitis

without gall-stones. It varies from a dull discomfort or ache to a sharp lancinating or colicky pain like gall-stone colic. In 12 cases the pain was severe. In the majority of cases where the pain was colicky the gall-bladder was diseased. Nausea or vomiting, or both, comes next to pain in frequency; it is not characteristic. Jaundice is the third important symptom. It was, or had been, present in 24 cases. This is not necessarily due to mechanical obstruction of the common duct, as it passes through the head of the pancreas, as it does in two-thirds of the cases, but may be due to disease of the bile-passages themselves or an extension from catarrh of the duodenum. The association of jaundice and rapid wasting which may occur simulates malignant disease.

Other symptoms are loss of weight, slight fever, and constipation. The treatment should be at first chiefly dietetic, and is directed to the causes of the condition if known. Operative treatment is indicated by continued loss of weight, persistence of indigestion, recurring exacerbations, jaundice, or a lowered tolerance for carbohydrates.

Gobiet[10] classifies the surgical treatment in three groups:

(1) *Treatment Based on Symptoms.*—Cholecystostomy and cholecystenterostomy for biliary obstruction, due to compression of the common duct by enlargement of the head of the pancreas. Gastro-enterostomy in rare cases of compression of the duodenum from a like cause.

In a case reported by Reynier and Masson[24] the pyloric obstruction was found to be due to a small aberrant lobule of pancreas lying beneath the mucosa of the pylorus, while in Lerat's[15] case the duodenum was narrowed by an annular pancreas; here the constricting ring of pancreatic tissue was removed.

(2) *Treatment Based on the Cause of the Pancreatitis.*—As the majority of cases are due to biliary infection, and as treatment of the lithiasis cures the resulting pancreatitis, he advocates "hepaticus drainage" (Kehr). He favors cholecystectomy (because the gall-bladder is so often useless for drainage) or cholecystenterostomy.

(3) *Operations on the Pancreas Itself.*—These may involve incision or even excision of part of the gland. Incision may be needed when calculi are felt in the ducts. He quotes Martina, who incised the thickened peritoneum over the enlarged pancreas, thus procuring relief from pain.

The majority of surgeons follow Robson in preferring cholecystostomy or, if permanent drainage is required, cystenterostomy, if the gall-bladder is sufficiently healthy.

Link[17] reports a case of chronic pancreatitis associated with a diffuse deposit of calculi throughout the organ, which he treated by pancreatostomy. The patient was a young woman, who had suffered since she was a little girl with occasional spells of vomiting. For the last five months she had been worse and suffered continually; any slight exertion would bring on a paroxysm of pain in the left side on a level with the kidney, and down the course of the ureter. Examination revealed nothing but local tenderness under the left costal margin and along the left ureter. As the symptoms suggested diseases of the left kidney,

this was first explored through a lumbar incision. The kidney itself appeared to be fairly healthy, but in close relation with it "was a peculiar, pointed object, which felt like a bag of fine sand. It was about the size and shape of a moderately distended gall-bladder. It occupied the anatomic position of the tail of the pancreas, and was recognized as such." This wound was closed, and an abdominal incision made through which the gall-bladder, ducts, and stomach were found to be normal.

The pancreas was explored through an opening in the transverse mesocolon. It was found symmetrically enlarged and felt like a bag filled with sand. Since it was apparent that the stony deposits in the parenchyma could not be removed, it was decided to attempt direct drainage. The peritoneum over the pancreas was incised, and the tail of the gland enucleated until the superior mesenteric vessels were reached. This was sufficient to allow the tail to be brought out of the wound. After packing the wound with sponges, the tail of the pancreas was split longitudinally, opening the duct of Wirsung, which was found to be dilated and filled with small facetted stones. These stones were removed and a No. 16 French soft catheter placed in the duct and the gland carefully closed around it. The opening in the mesocolon was closed and stitched to the pancreas, and the suture line in the pancreas was covered with omentum and a gauze drain placed below the pancreas. An ordinary rubber condum was tied over the end of the rubber tube to collect the secretion.

The result of this operation was very satisfactory, the patient gained weight and had no further attacks of pain. The quantity of fluid discharged externally gradually diminished, and at the time of the report amounted to only a few ounces daily.

CYSTS AND PSEUDOCYSTS OF THE PANCREAS.

A large example of the former is reported by Hirst and Veeder.[11] At the operation the cyst was found to lie in the lesser peritoneal cavity and was free from adhesions, being attached by a pedicle to the head of the pancreas. After excision, the wall of the cyst was found to contain pancreatic tissue, and its contents showed the presence of enzymes.

Körte[14a] reports 6 cases of inflammatory pseudocysts treated by marsupialization. In all these cases there had been previous symptoms suggesting gall-stone colic. A case in which a pseudocyst followed an attack of acute pancreatitis is recorded by Stoney.[29] The first operation was undertaken for symptoms of biliary colic with slight jaundice and elevated temperature. The gall-bladder and ducts were found to be normal, the pancreas was large and hard, and fat necrosis was present. Cholecystostomy was performed, and a week later several small stones escaped. Six weeks later a swelling appeared in the left hypochondrium and increased to the size of a football. This was found to be a large tense cyst, presenting above the stomach. It was incised and drained. Telling and Dobson[30] have recorded a pancreatic cyst, lined with cylindric

epithelium, in a child of eleven, while Conolly[6] found a large one in an infant aged fourteen months.

Following operations upon the pancreas, more especially after drainage of cysts, there is frequently a continued discharge from the wound, which, by reason of the contained digestive ferments, is intensely irritating to the skin. In such cases a strict antidiabetic diet is advised by Wolgemuth. Ointments applied to the skin should have a basis of paraffin rather than one of animal fat, which is rapidly digested and serves only to increase the irritation.

TUMORS OF THE PANCREAS.

Cancer of the body of the pancreas forms the subject of an article by Leriche,[16] who reports 3 cases of his own and has collected 16 other cases from the French literature. In the majority of cases the onset is marked by severe pain in the left hypochondrium, spreading to the midline, and radiating to the back, chest, and shoulder. These attacks of pain become more frequent and prolonged, and may closely resemble the crises of tabes. He explains the pain by the close relation of the tumor to the celiac plexus. Leriche suggests the feasibility of an operation for these cases, which involves dissecting up the tail and body of the pancreas as far as the neck.

Körte[14b] has recorded a case of pedunculated fibroma of the pancreas which was successfully extirpated.

The successful removal of a sarcoma from the head of the pancreas is reported by Sherren.[28] The tumor was shelled out of the pancreatic tissue; the patient was well at the time of the report, about one and a half years later. A large polycystic sarcoma of the pancreas is reported by Villard and Stefani.[32] In this case the cyst was marsupialized; death occurred on the seventh day.

A case in which resection of the pancreas was successfully practised for the removal of a primary solid tumor (benign cystadenoma) is recorded by Finney.[9] At the operation the tumor was found to be about the size of a lemon, and involved the whole middle portion of the gland. At either end there was left a little apparently normal glandular structure. The tumor was excised with the whole middle portion of the gland, the remaining portions of the head and tail being then carefully sutured together. The patient made a good recovery, though a fistula developed and discharged for about three months.

Finney also collected from the literature 16 other cases of primary tumor of the pancreas which had come to operation. In 3 cases the gland was completely divided and then sutured; all three recovered.

A noteworthy feature in the history of many of these cases is the mobility of the pancreatic tumor. This is noted by Körte, Sherren, and Finney, who also states that in over 25 per cent. of the cases he collected from the literature the tumor was extremely movable.

For the purpose of draining the gland after partial pancreatectomy, or as a means of affording relief in cases where there is an obstruction at

the mouth of the pancreatic duct which cannot be removed, Coffey[5] has devised an operation which he designates pancreato-enterostomy. The method consists in the insertion of the cut end of the pancreas into a loop of intestine, the end of which has been turned in so as to provide a complete peritoneal collar to clasp the pancreas. Since the caliber of the small intestine is generally too small to accommodate the pancreas, he sutures two parallel limbs of intestine together in such a manner as to convert them into a single tube of wide caliber. (The method closely resembles that employed in Finney's gastroduodenostomy or pyloroplasty, with the exception that the apex of the loop is left open.) The open end of this tube is then folded in by means of temporary traction sutures, and the cut end of the pancreas, after being prepared by stripping the glandular tissue from the duct so as to leave about ½ inch projecting, is inserted within it and fixed by sutures, which are finally buried by further infolding the intestinal tube. Animal experiments show the feasibility of the method.

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CHAPTER CXXX.

SURGERY OF THE SPLEEN.*

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Prominent among the recent articles on this subject is one by Mayo,[18] in which he gives the results of his experience in the surgery of the spleen. Recent investigations lead him to suggest that many of the anemias and associated blood states may ultimately be best treated by operative procedures directed to the spleen and other blood-forming organs.

In operations on the spleen he considers that a most important step is to grasp the vascular pedicle temporarily in the rubber-covered elastic clamps. If partial resection only is to be done, this temporary compression seems harmless.

It has been shown experimentally that reduction of the blood-supply by ligation of some of the arterial branches entering the spleen results in atrophy of the organ, and as long as the veins are left intact necrosis will not occur.

Mayo suggests this ligation of some of the branches of the splenic artery in place of partial splenectomy as a means of reducing the size of the spleen.

He reports 10 splenectomies with 9 recoveries. One was a huge lymphosarcoma; the patient was well three and a half years later. One patient recovered from splenectomy for primary tuberculosis of the spleen, but the later history was not known. Four cases of splenic anemia were all cured or greatly benefited by splenectomy. There were 2 cases of Banti's disease, 1 of which died from hemorrhage and shock twelve hours after the operation. The 2 remaining operations were for splenomegaly of unknown origin; both recovered.

In connection with Mayo's remark on the harmlessness of temporary clamping of the pedicle, it may be noted that Sheldon[21] advises the temporary application of flexible clamps to the pedicle in the treatment of wounds of the spleen. The clamp should be left in place four hours and then loosened, when re-establishment of the circulation will take place, though bleeding will not recur. Experiments on dogs showed that the circulation through the spleen might be arrested for six hours without necrosis resulting, provided that no attempt was made to suture or pack the wounds.

* Supplementary to Chapter LII., Vol. III., p. 1068.

Kirchner[13] describes a method of treating hemorrhage from the spleen by suture and encapsulation instead of splenectomy. The spleen is delivered into the wound and the edges of the rupture approximated with deep sutures; the wounded part of the spleen is then wrapped in omentum, returned to the abdomen, and fixed in position by gauze packs. He reports 1 case of bullet wound and 3 ruptures treated thus, with 1 death.

An interesting commentary on these methods is afforded by a case reported by Lukis,[15] where operation forty-two hours after the injury showed that the hemorrhage had ceased spontaneously, though the spleen was badly lacerated and held in place by a mere strand of mesentery. The bleeding from a ruptured malarial spleen is slower than from a lacerated healthy organ; this is attributed by Solieri[22] to the large amount of connective tissue found in these enlarged spleens.

Levy[14] has called attention to the value of pain in the left shoulder as an aid to the diagnosis of injury to the spleen. This is explained by the association of the phrenic with the fourth cervical nerve. He thinks this sign may be of use in cases where there is so much abdominal distention and pain that a local examination is unsatisfactory.

A useful comparison between bullet and stab wounds of the spleen is drawn by Thévenot.[24] He gives tables showing the results of treatment in 71 cases:

	Bullet wounds.		Stab wounds.	
	Cases.	Died.	Cases.	Died.
Splenectomy	26	12	7	2
Suture	4	1	18	3
Tamponade	12	6	4	0
Totals	42	19	29	5

Suture appears to be the method of choice in stab wounds. If there is a wound of the thoracic wall the transpleural route will be sufficient if the opening in the diaphragm be enlarged. In cases where the spleen is wounded by a bullet, it is often so lacerated that suture is impossible and splenectomy is demanded. This has the further advantage of giving more room and so facilitating the search for wounds of other viscera. In only 2 of the 69 cases of bullet wounds collected by Girgolaw[9] was the spleen the only organ injured.

In Oppel's[19] case both splenectomy and nephrectomy were successfully performed on account of the injuries inflicted by a revolver bullet. A similar procedure was necessary in a case recorded by Caplesco[4] on account of subcutaneous laceration of the spleen and left kidney. This patient also recovered.

In the case of a bullet wound of the spleen entering through the thorax the transpleural route will not be sufficient. Such a case is described by Halstead;[10] on opening the thorax both the pericardium and diaphragm were found to be wounded, and through the latter blood was escaping from the abdominal cavity. Both wounds were sutured and the abdomen explored through a fresh incision. The spleen was found torn into several fragments and was removed; the patient recovered.

ECTOPIC SPLEEN.

Maclaren[17] relates the interesting case of a woman, aged fifty-one, who suffered from attacks of palpitation, dyspnea, and depression. Examination revealed an irregular tumor fixed in the right side of the pelvis. Operation showed the tumor to be a wandering spleen with a twisted pedicle. He mentions a case in which Ritchie was able correctly to diagnose a spleen in the pelvis by recognizing the notch.

In Maclaren's case the pedicle was 10 inches long and had undergone two complete turns; this was not enough to interfere with blood-supply, and the spleen was normal in size and consistency. Examples of pelvic spleen, with acute torsion of the pedicle, have recently been recorded by Solieri, Paterson,[20] and Macdonald and Mackay.[16] In all these cases splenectomy was undertaken, with recovery.

Johnston[12] has collected 18 cases of splenectomy without a death for ectopic spleen with twisted pedicle between 1900 and 1908.

NON-PARASITIC CYSTS.

The ideal treatment for these is, according to Bircher,[2] resection of the cyst. Among 33 cases of non-parasitic cyst treated surgically there were 4 resections with 1 death. On the other hand, splenectomy appears to be safer (15 cases without a death). Johnston brings this total up to 19 splenectomies without a death.

Finkelstein[6] gives the results of surgical treatment in 66 cases:

	Cases.	Deaths.
Puncture or opening with caustics	11	2
Incision and drainage	19	1
Resection of cyst	7	1
Splenectomy	27	2
Various other methods	2	1
	66	7

A multilocular cystic spleen removed by splenectomy is reported by Coenen.[5] The organ contained very numerous cysts of variable size, with clear contents. He thinks the cysts were of lymphangiectatic origin. A very similar case is recorded by Fowler,[8] which he regards as more in the nature of a new-growth—a lymphangioma.

SARCOMA.

Bush[3] records the case of a man with a hard irregular tumor in the left hypochondrium, descending toward the umbilicus on deep inspiration. While he was under observation he went for a long ride on a street car, and on his return complained of an increase of pain. During the night he was heard to fall, and was found in a fainting condition. In the morning he was collapsed, restless, thirsty, and cyanosed, with a rapid pulse. The abdomen was slightly distended, rigid on the left side, tender, and showed movable dulness.

At operation the spleen showed some whitish bosses on its surface, suggesting sarcoma. It was ruptured on its mesial aspect. The rent was temporarily packed with gauze and splenectomy was performed during the next week, when his condition had improved.

The man recovered from the operation, but died three or four months later from metastases.

Among Johnston's statistics are 12 splenectomies for sarcoma with 3 recoveries.

PRIMARY TUBERCULOSIS.

Twelve cases of splenectomy for tuberculosis of the spleen with 4 deaths have been collected by Fischer.[7] He considers that these deaths should not be entirely attributed to the operation, which affords the only hope of cure, for the course of the disease without intervention is fatal.

Fischer's own case is interesting, for the patient came to be cured of a ventral hernia in the scar one year after the splenectomy. At the second operation the opportunity was taken to examine the interior of the abdomen, and it was found to be free from all evidence of tubercle.

SPLENIC ANEMIA AND BANTI'S DISEASE.

Banti[1] has made a careful study of 50 cases, made up of 32 females and 18 males. Twenty-six of his patients had always enjoyed previous good health, and in all the histories there is a complete absence of former gastric trouble, diseases of the liver or ducts, malaria or lues.

He divides the course of the disease into three periods. The first period may last from three to five years, even as long as twelve, and is characterized by gradual enlargement of the spleen. Less constant, often only slight or late in the disease, is anemia. This is secondary in type, the color index is lowered, a true leukocytosis never exists, a total leukopenia is frequent, but not constant; there is an absolute or relative increase in mononuclears even in extreme leukopenia; normoblasts and myelocytes are absent.

In the second period there is a diminution in the quantity and an increased concentration of urine; the liver enlarges, but the spleen remains about the same. This stage may last several years.

The third period is marked by the onset of painless ascites, the fluid having the characters of a transudate. At this period the liver shrinks and becomes cirrhotic. There is no true icterus, but the skin becomes clay colored and hemorrhages may be observed. Death follows generally from hemorrhage, or auto-intoxication from liver atrophy.

In the treatment drugs are absolutely worthless and *x*-rays no better. The only efficacious treatment is splenectomy. If this is done in the first period, the anemia and hyposthenia disappear; and, further, this cure appears to be lasting, for he has observed cases thirty-five, six, and five years after with no recurrence.

If in the second period, the anemia appears to be cured, while the commencing cirrhosis may be stayed.

In the third stage either splenectomy, splenectomy and Talma's operation (Torsini), or splenopexy (Schiassi, Rossi) have been carried out. Those patients who survived the operation appeared to be cured.

The following table includes Banti's own and collected cases of splenectomy:

	Cases.	Recovered.
First period	4	3
Second period	22	13
Third period	4	1

In addition to these there were 4 cases of splenectomy combined with Talma's operation with 2 recoveries, and 2 cases of splenopexy with recovery.

He urges operation in the first period of the disease, when the mortality is 25 per cent. In the second stage it is 40 per cent., and in the third, 60 per cent.

It has been suggested by Hill[11] that there are two types of splenic anemia, which he terms the "hemolytic" and "cachectic" types. He gives the following table of differentiation:

Symptoms.	"Hemolytic."	"Cachectic."
Pigmentation	Common.	Never.
Hematemesis	Common.	Rare.
Other hemorrhages	Rare.	Common.
Relative lymphocytosis	Only with marked leukopenia.	With slight leukopenia.
Myelocytes	May occur.	Never.
Normoblasts	May be numerous.	Few are not rare.
Megaloblasts	May be numerous.	Never.
Color index	Often one or above.	Rarely .9, never above 1.
Falling count with rising index	Almost always.	Never.

It will be seen that the blood changes in the hemolytic type resemble those of pernicious anemia.

Splenectomy cures the cachectic, but not the hemolytic type, though it may relieve symptoms and delay the commoner causes of death.

Sutherland and Burghard[23] report 2 cases of splenectomy for splenic anemia in children. They accept, as the essential characters of the disease: (1) anemia of the chlorotic type; (2) absence of leukocytosis, usually leukopenia; (3) considerable enlargement of spleen not due to any other known cause.

The appearance of patients suffering from this affection, profound pallor and a creamy tint of the skin, is very striking. They express the hope that it may be possible to regard the rapid disappearance of all symptoms after splenectomy as another criterion. They are also inclined to think that the juvenile type of splenic anemia tends to run a more acute course than in adults. Hematemesis is less common in children.

The 2 cases reported were girls aged twelve and six. The first case was operated on in 1906, after x-rays had been used with no benefit. She was seen four years later, quite well. The second case was greatly improved at the time of the report, two months after operation. In each case the red blood-cell count reached normal a few weeks after the operation, and the hemoglobin showed a rapid improvement.

As regards the technic of the operation, Burghard first divided the gastrosplenic omentum between forceps: this allowed the spleen to be further rotated outward, and brought the lienorenal ligament within easy reach. This was clamped in two places and divided. He recommends that the branches of the splenic artery in the lienorenal ligament should be ligated as soon as they are divided, otherwise the ligament retracts and is difficult to reach.

They conclude by saying that a preliminary course of medical treatment will naturally be adopted in all cases of splenic anemia, but experience has shown that it is never curative, and if the diagnosis is clear, splenectomy should not be unduly delayed.

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CHAPTER CXXXI.

DISEASES OF THE RECTUM.[1]

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The recent advances in proctology have made more evident the necessity for thorough examination of this portion of the body before making a diagnosis or attempting treatment. The main advantage that the proctologist has over the general practitioner in the treatment of these conditions comes from the more thorough examination which he gives his patient, and hence more accurate and early diagnosis, and helpful treatment. The methods of examination have not changed so much recently, but the value of the proctoscope has become more evident.

Rectal and sigmoid examination should be made in all persistent constipations and diarrheas; and in all conditions with a discharge of blood and glairy mucus, as well as in those in which pain and more obvious symptoms indicate it. It is the early diagnosis, dependent on the early thorough examination, that offers the best returns to both patient and surgeon.

Fistula in ano at the advanced stage, especially if of the tuberculous type, has been treated very successfully by excision in place of incision. This method of treatment is of special advantage where there has been much formation of fibrous tissue in the wall of the fistula, embedding therein vast numbers of bacteria. Since the great majority of fistulæ have their internal opening between the external and the internal sphincters, complete excision is perfectly feasible.

Preparation of the Patient.—All surgical operations upon the rectum are best anticipated by two or three days' preliminary preparation to eliminate effete matter from the bowel. In operations upon cancer of the rectum it is even more important, inasmuch as there is apt to be decomposing blood and tumor secretion lurking about. In these cases there is apt to be a partial stricture, above which old stercoral masses are found. Several days of preliminary cleansing may then be necessary. If the obstruction is not great a sweeping cathartic like castor oil is most efficient, and should be repeated on three nights, in smaller doses, as needed.

An enema of olive oil and warm soapsuds is sufficient to cleanse the rectum. If it can be carried above the diseased part it will be doubly efficient. The operator's assistant should cleanse the rectum and

[1] Supplementary to Chapter LIV., Vol. IV., p. 110.

sigmoid by a careful irrigation above and below the disease, and siphon off all fluid used for this purpose (normal saline solution) just prior to the operation, otherwise there will be a flood of fecal matter, which soils the operative field.

After this careful preparation of the patient and cleansing of the rectum, the sphincter should be thoroughly dilated, a probe passed into the fistula, and its exit into the rectum located. Then an elliptic incision is to be made around the cutaneous end of the fistula and extended toward the anus, following the course of the probe. The tract is then dissected out along the thickened tissue discovered around the fistula by palpation. Care should be taken to feel for any side tracts of thickened tissue around the main fistula and to follow them as far as the dense tissue can be felt. The dissection of the main tract is carried through the mucosa and the rectal mucosa sewed up, leaving the scar with its long axis in the long axis of the rectum, so that any cicatricial contracture will not tend to cause narrowing of the lumen of the alimentary canal. Enough deep sutures are placed to obliterate the dead spaces, and the skin wound closed except for a wick of rubber tissue which can be removed on the third day. The wound heals by primary union and the patient leaves the hospital in ten days with no need of further dressings. In some cases it may be more convenient to do a primary incision of the main tract from fistulous skin opening to mucous membrane, and then dissect out the thickened tissue and the devious side tracts. This method lays the adjacent healthy tissues open to infection, but gives a better exposure of the secondary tracts, which can thus be probed from their orifices. Here disinfection of the tissues after excision of the tract is necessary, weak tincture of iodin being one of the best disinfectants. The use of pure carbolic acid would tend to produce slough and (later) secretions that interfere with the primary healing of the wound. In these cases the rubber tissue drainage in the wound should not be forgotten.

In the **rectal incontinence** that follows fistula operations with multiple division of the sphincters, not sutured at the time of the fistula operation, a plastic restoration of the sphincter is most desirable. The identification of the ends of the muscle and the intervening fibrous tissue can be made under an anesthetic by stimulation of the muscle with the Faradaic current. When the fibrous tissue has been excised and the ends of the muscle united the sphincter should be tested again by the battery to see that it functionates satisfactorily.

The **ulcers of the rectum** may be differentiated in type to a certain degree by the recently perfected serum reactions: the Wassermann reaction in suspected syphilitic conditions, and the tuberculin reaction in suspected tuberculous conditions. The possibility of other lesions in the body being responsible for the positive serum reaction must, of course, always be kept in mind. In the treatment of the syphilitic lesions, Ehrlich's new arsenic preparation, salvarsan, seems to offer wonderful results. In cases that have resisted mercurial treatment it certainly should be used. Its primary use (after diagnosis by the Wasser-

mann reaction) is widely advocated. In the treatment of other inflammatory conditions autogenous vaccines may be used to advantage to supplement other lines of treatment.

The importance of the **rectal valves of Houston** has been emphasized by Martin as a cause of constipation when the valves are abnormally large, and of stricture when the valves are infiltrated with inflammatory products. Treatment by nicking the edge of the valve through the proctoscope, called valvotomy, suffices to remove the effect of the redundant valve, while massage and hot applications may cure infiltrated valve strictures that simulate neoplasms.

In the *hemorrhoidal conditions* we feel that most thorough examination should be made before regarding the hemorrhoid as primary or deciding lightly on operation to remove the evident trouble. Two cases recently came to our knowledge which will illustrate this point. In one the hemorrhoids were already gangrenous and the patient septic, dying within twenty-four hours after admission to the hospital. While death was due to sepsis, yet autopsy showed a marked hypertrophic cirrhosis of the liver and advanced sclerosis of the kidneys which had given no evidence of their existence. In all probability these would have been stirred up from quiescence into acute hepatic and renal incompetency by the hemorrhoid operation under a general anesthetic. The operation would have been justifiably undertaken if the man had been admitted to the ward a few days earlier and had not been so far advanced in sepsis. The other case was one associated with diabetes. The man was operated on for the hemorrhoids, but died in coma two days later.

Hemorrhoids are often an indication of cancer higher in the canal.

Thrombosis of the hemorrhoidal vessels, while often made little of, is at times serious from the likelihood of infection and sepsis. If the clot is turned out promptly the procedure is simple and the result very satisfactory. If the thrombosis is neglected until infection of the clot takes place, the healing of the abscess takes much longer.

Intractable pruritus ani at times assumes a prominence sufficient to demand surgical attention. After exhausting medical measures (lotions of carbolic acid, painting with iodin, etc.), the simplest surgical treatment is to cut all the cutaneous nerves by dissecting up the skin in four angular flaps outlined by four radiating incisions from the anus. No sutures are needed, as the skin flaps drop naturally into place.

In many rectal conditions a temporary or even permanent **colostomy** is needed, and, as an improvement over the iliac, Edwards suggests a hypogastric colostomy as giving better control, without prolapse or hernia, a more conveniently placed anus, and, incidentally, at operation the sigmoid colon is more easily found. If, however, a secondary laparotomy is anticipated, as, for instance, for the removal of a rectal cancer, then the right iliac or lumbar operation places the anus farther from the field of operation, with better prospect of keeping the second operation sterile. In the hypogastric colostomy a vertical incision is made 3 inches long over the middle of the lower third of the left

rectus, the fibers of the rectus being separated as the incision is deepened. The incision being near the median line allows intra-abdominal exploration, if desired, of the full length of the rectum and sigmoid, and, in some patients, of the liver. The sigmoid is brought into the wound, care being taken that the proximal portion remains above, so that the intestine is not twisted. Then the sigmoid is pulled taut, so as to make the opening as high as possible in the colon and leave as much as possible below for secondary resection with the rectum. This also prevents prolapse of the sigmoid into the wound. Permanent sutures are then passed through the mesentery, two on each side, both above and below the center of the incision, and carried through all the tissues of the anterior abdominal wall except the skin and superficial fascia. This makes four points of permanent adhesion between mesentery and abdominal wall. Then the glass rod passed through the mesentery separates the two upper from the two lower permanent sutures, and raises the sigmoid above the skin. The wound is then closed above and below the intestine, which is anchored by sutures through the thick longitudinal bands and the skin. Protruding appendices epiploicæ are cut off and the intestine left to be opened twenty-four or forty-eight hours later. If, for any reason, still more positive control of the anus is desirable, a second shorter skin incision may be made an inch to the left of the first incision. In this the fibers of the rectus are separated in a horizontal plane, and the loop of intestine brought first through the laparotomy wound and then carried transversely through the fibers of the rectus and out at the secondary incision, and there sutured over the glass rod. This allows the skin and fascia of the first incision to be closed entirely, and lessens the chance of secondary infection of the laparotomy wound.

The **operations for cancer of the rectum** have changed materially in the past few years, owing to the careful study of the recurrences and the late results of the various modes of treatment. The operative statistics from the leaders in this line of work show marked improvement in both the primary mortality and in the permanent cures, no matter what the route of approach. Before the year 1900 the operative mortality of even the leaders was over 20 per cent., and the final results most discouraging, with recurrences in over 90 per cent. of the cases; many of the best men having recurrences in practically all of their cases. The primary mortality of the perineal operation was the lowest, the sacral moderate, and the abdominal or combined abdominal and perineal so high that recovery from the operation was the exception. However, within the past ten years the technic of all the operations has been greatly improved, the operative mortality for many dropping below 5 per cent., and the percentage of permanent cures increased a great deal. W. J. Mayo has reported 120 cases of cancer of the rectum operated on: 38 by the perineal route, 56 by the posterior route, and 26 by the abdominoperineal route. The mortality of the entire series was 16 per cent., but the last 44 cases had a mortality of only 4 per cent. Tuttle reported 100 cases operated on prior to 1908, with an operative mortality of 13

per cent. Since then he has operated on 44 more. Of these, only 1 that came to operation within ten months of the first symptoms has been lost. Von Herczel, operating in all cases, has an operative mortality of 15 per cent., and claims 21 cases (55 per cent.) living five years or more after the operation. Miles, up to 1906, doing the perineal operation in 59 cases, had but 1 operative death, but 54 recurrences (92 per cent.). One had died seven years after operation from some intercurrent condition, and 3 were still alive and well after over four years. But since 1906 Miles has done a very radical combined operation on 26 cases. Of these, 10 (36 per cent.) had died within the first twelve days after operation, 1 died thirteen months later of some intercurrent condition without recurrence, 1 was not seen later, and 2 were just recently out of the hospital. The other 12 were all still well and without recurrence, 4 of them having passed three years. Hence, while his mortality has gone up tremendously, his freedom from recurrence has been most exceptional.

The main factors that have led to the better results have been the extreme care to prevent sepsis by cleaning the rectum and keeping it clean until the wounds have healed, and the better preservation of the blood-supply to the severed ends of the bowel.

The control of sepsis has been largely through thorough preparation of the colon by careful feeding with food containing little residue, efficient catharsis, and thorough washing out of the rectum. Practically all of these cases, where there is any retention of the intestinal contents, show an auto-intoxication which can be cleared up by emptying the bowels, but if there is marked stenosis a preliminary colostomy may be necessary to carry out this part of the preparation. In any case for a week prior to operation only concentrated foods—meat, broths, milk, white bread, and refined cereals—are allowed. The bowels are moved daily by salines and irrigated with salt solution. The use of daily doses of salol is also advocated during this period. No movement of the bowels is allowed after operation for at least one week, while the concentrated food diet is continued.

The better late results have followed more careful cleaning out from the pelvis of all tissues near the seat of the cancer. Miles' careful study of recurrences in his cases shows that they appear in certain tissues which he groups into three zones of spread: downward, lateral, and upward. The downward group includes the wall of the rectum below the lesion, the external includes the wall of the rectum below the lesion, the external sphincter, the perianal skin, and the fat of the ischiorectal fossa. These tissues were involved in recurrences in all the cases of his earliest operations, the skin and fat being most constantly involved. The lateral group of recurrences includes the levatores ani, the perirectal fascia, the presacral tissue, and in the male the prostate and in the female the vagina and broad ligament. These tissues were also involved in the recurrences of practically every case. The group of upward spread included the bowel wall above the lesion, the pelvic peritoneum, and the pelvic mesocolon, with the lymph-nodes at the bifurcation of the

left common iliac artery. Resection of the intestine 3 inches above the growth, with the removal of all the tissues of the lateral and downward zones, failed to control the upward spread, and even greater removal of the colon and mesocolon was followed by recurrence in the mesocolon and the pelvic peritoneum. Miles says that "free extirpation of the tissues of the downward and lateral zones of spread generally prevented recurrence in the field of operation. But however free the extirpation of the tissues comprising the downward and lateral zones of spread may have been, recurrence will, in all probability, take place among the tissues of the zone of upward spread. The most complete and extensive perineal operation possible is, with few exceptions, quite inadequate for preventing a recurrence of the disease." The whole pelvic colon must be removed and the whole pelvic mesocolon cleaned.

In the less radical operations recurrences are very apt to occur, but for the sake of retaining the normal anal sphincter Lusk has described an abdominoperineal operation based on careful study of the blood-supply, demonstrating that it is feasible to get a fairly bloodless operation by ligature early in the operation of the sacral artery, the internal iliac vessels, and the superior hemorrhoidal or inferior mesenteric artery at the promontory of the sacrum, together with one of its branches to the sigmoid colon. This allows ample circulation for the greater part of the rectum and of the pelvic colon. It has been demonstrated also that one of the factors causing the inability to draw the rectum and sigmoid down to the anus was the attachment of the sigmoid branches of the mesenteric artery, and the ligature and cutting of these vessels allows much greater mobility of the colon.

The **technic of the abdominoperineal operation** as described by Lusk includes a median abdominal incision in the high Trendelenburg position, incision of the peritoneum parallel to the rectum over the promontory of the sacrum, with ligation of the superior hemorrhoidal artery, loosening the posterior surface of the rectum down to the bladder, reflection, freeing the retrorectal tissues from the last vertebra to the tip of the sacrum and laterally to the internal iliac artery, which, as well as the middle sacral, is also tied. The deep lateral attachments of the rectum are then dissected up, enucleating *en masse* the fat and glands in the hollow of the sacrum up to the bifurcation of the aorta. The sigmoid colon is liberated until there is a free descent of 6 inches of healthy colon below the left common iliac vessels by cutting the left perineal attachment of the bowel to a point high up in the iliac fossa, and through this opening stripping up out of the fossa from left to right the layer of vascular supply to the bowel. Then the superior hemorrhoidal artery and one sigmoid are ligated. This completes the abdominal dissection. The pelvic peritoneal opening is narrowed and the abdomen closed. Next, with the patient in Sims' position, the perineal incision is made in the median line from the fourth sacral vertebra to the base of the coccyx, and then diagonally to the right to terminate an inch or more to the side of the posterior margin of the anus. The gluteus maximus is cut along the coccyx and the coccyx

disarticulated, freed from the tissues in front of it, and swung to the left. The precoccygeal tissue is cut across transversely ½ inch below the tip of the sacrum and an incision made on the left side, starting opposite the sacrococcygeal joint and passing out and down in the line of the fibers of the gluteus maximus. This forms a right-angled flap containing the postanal median line structures severed at the base of the coccyx. The fascia propria recti is stripped forward from the anterior surface of the bodies of the sacral vertebræ from below up to where it communicated with the part opened from the abdomen. The liberated loop of intestine is drawn down out through the posterior wounds and the pelvic peritoneal opening closed from below with gauze. Then, with the patient in Kraske's position of vertical elevation of the hips and extension of the thighs over the abdomen, the bowel is freed down to a little above the internal sphincter, where it is clamped and divided. The edge of the anal section is caught in silk traction sutures at intervals as it is cut. The severance above the tumor is also made by interrupted cuttings, beginning anteriorly, and united immediately to the distal piece following Kraske's method. The edges of the skin are closed except for the free drainage, and a rubber tube laid in the anal canal through the stretched, but not divided, sphincters.

Miles' operation is very radical and formidable and necessitates an abdominal anus. He uses a median laparotomy, and begins by dividing the colon between the upper and middle sigmoid arteries after applying a double ligature. The extremities of the intestine are then invaginated and buried, the upper kept for the colostomy at the end of the laparotomy, while the lower end is to be removed. The pelvic mesocolon is divided close to the inferior mesenteric artery between the middle and upper sigmoid branches, care being taken to identify and isolate the left ureter before ligature, as it crosses the artery near that point. The rest of the pelvic mesocolon is then divided and the pelvic peritoneum incised parallel to the colon and an inch away from it, down to the rectovesical reflexure. In women the left tube, ovary, and broad ligament are also removed. The lateral margins of the peritoneum are dissected free, so as to close up the peritoneal deficiency left after removing the colon, and the pelvic floor restored. The colon and rectum are freed, beginning above where the artery was tied, and all of the tissue cleared from over the bifurcation of the common iliac artery, as well as the rectum, watching for the left ureter. The dissection is carried down until the levatores ani are free, and then the rectum and colon crowded down and covered with gauze. The lateral edges of the peritoneum are brought together. In front the peritoneum from the bladder will cover the space, or possibly the uterus will have to be used to fill the deficiency. The inguinal intermuscular colostomy is then made, to be opened after the perineal operation is finished. Then the abdominal wound is closed, leaving 2 or 3 pints of salt solution in the abdomen. The perineal portion of the operation is then done with the patient in Sims' position, after a purse-string suture has closed the anus. A transverse incision at the level of the sacrococcygeal joint is made, and from its center a median cut

to within an inch of the anus which is circumscribed by an elliptical incision at least an inch away from the anus, and taking as much skin as possible. The skin is reflected, the coccyx removed, the fascia propria ani cut, and the interval between the levatores defined. The rectum is dissected free from the vagina or the prostate. The levatores ani are then cut free at their origins from the pelvic wall and the colon and rectum lying free above them drawn out. The cutaneous wound is closed with ample drainage. The operation is formidable, and in Miles' hands requires nearly two hours for completion, but it is the best operation yet offered for the complete eradication *en masse* of all the danger area.

The Use of Radium in Rectal Cancer.—From the earliest advocacy of radium in growths of malignant type, it has been the hope of the surgeon that in internal growths as well as in cutaneous epitheliomata there would be found a field of great usefulness. Nowhere is it more desired than in the treatment of cancer of the rectum, uterus, vagina, esophagus, and other places inaccessible to the knife, when the disease has advanced to a stage where operation is either disastrous or fruitless.

Experienced operators, knowing the limits of surgical usefulness, have ventured to try radium in the hope of ameliorating, retarding, or destroying cancer of the rectum.

Little or nothing has been written as yet that can be said to demonstrate its efficacy.

The reasons for this are: the difficulty of knowing how to apply it correctly; the infrequency of cases which are not open to some form of operation; the long time after treatment before demonstration can be assured; and, finally, the doubt in the surgeon's mind whether his treatment has been well enough applied to be counted as a test worthy of report.

What I shall say, therefore, will represent only the result of my own personal work in this field after its extensive application in every other field since its first discovery. The 15 patients in whom I have studied radium treatment of rectal cancer represent experimental work.

This means that the amount of radium used and the time exposure varied, as well as the method of its application. Each year shows improvement in results.

The best step in advance seems to be in reliance upon Wickham's method of filtration.

My radium specimens have been of the strongest, and have been contained in thinnest glass tubes, which were at first held only in a rubber finger-cot, by which only the alpha-rays were excluded.

In recent years I have uniformly increased the strength of the dosage, but confined the tubes within lead tubes of varying thickness, so as to exclude the burning alpha- and soft beta-rays.

By thus utilizing only the gamma- and hard beta-rays I believe the utmost efficiency has been secured and longer exposures permitted.

When only the rubber was interposed between the glass radium tube and the rectal lining, there would often follow a tender radium burn, which would last several days.

At present the use of a lead cylinder 2 mm. thick permits an all-night application of 100 mg. with good effect and no burning. Such an application should not be repeated oftener than at eight weeks' interval.

The popular demand for a cure is as yet wholly unsatisfied, but the results of the radium treatment are, in my experience, both palliative and beneficial.

One needs a long training in observation, and a conservative, unbiased judgment to estimate the worth of so important a remedy in so grave a disease. One has to form an exact mental picture of the size of the growth, its touch, appearance, and anatomic relations (which are to be recorded), if one is to recall it at intervals of two or three months, during years of observation while studying other similar cases.

With conscientious consideration, therefore, I can testify to the diminution and retardation of growth, the prolongation of life by one or two years in some cases, and alleviation of neuralgic pelvic pains.

The only method worth trial in applying radium is to encase the tube in a cylinder of lead 2 mm. thick, closed by lead at each end, and attached to a wire several inches long.

The cylinder is enveloped in a rubber glove finger and passed into the rectum the desired distance. It is now secured in exact place by bending the wire at the anus and turning it upward along the sacrum to which it is held by an adhesive strip; 100 mg. of pure radium thus enclosed may be left in the rectum from four to ten hours; and the treatment repeated in eight weeks. A smaller amount of radium may be used and left proportionately longer. The effect ought to be the same.

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CHAPTER CXXXII.

THE PHENOLSULPHONEPHTHALEIN TEST OF THE FUNCTIONAL ACTIVITY OF THE KIDNEYS.[1]

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This test, described by L. G. Rowntree and J. T. Geraghty[2] in 1910, depends upon the prompt appearance of the dye in the urine and upon the fact that in normal individuals 60 to 85 per cent. of the amount injected is eliminated within two hours. The substance is non-irritant and non-toxic, producing no ill effect either at the point of injection or upon the tissues through which it is eliminated. By calorimetric methods the amount eliminated is determined with mathematic accuracy. In short, the test represents within narrow limits the exact degree of functional activity of the kidney, is easy of application, and may be used independently of other methods.

Technic of the Test.—This is as follows: Twenty to thirty minutes before administering the test the patient is given 300 or 400 c.c. of water by mouth in order to insure free urinary flow, as otherwise the delay in the appearance of the drug in the urine might be simply due to lack of secretion. The bladder is then completely emptied by means of a catheter introduced under aseptic precautions, and, noting the time, 1 c.c. of a carefully prepared solution[3] containing 6 mg. of phenosulphonephthalein to the cubic centimeter is administered subcutaneously, either in the arm or the buttock, by means of an accurately graduated syringe. The urine as it is secreted is allowed to drain through the catheter into a test-tube containing one drop of a 25 per cent. sodium hydroxid solution, and a note made of the time elapsing until the appearance of the first faint pinkish tinge. In patients without urinary obstruction the catheter is withdrawn at the time of the appearance of the dye in the urine, and the patient is instructed to void into a receptacle at the end of

[1] Supplementary to Chapter LV., Vol. IV., p. 168.

[2] An Experimental and Clinical Study of the Functional Activity of the Kidneys by Means of Phenolsulphonephthalein, Jour. of Pharm. and Exper. Therap., 1910, i., 579. Further Data Relating to the Value of Phenolsulphonephthalein in Estimating the Functional Activity of the Kidney, Jour. of Pharm. and Exp. Therap., 1911, ii., 391.

[3] 0.6 gm. of phenolsulphonephthalein and 0.84 c.c. of $\frac{2}{N}$ NaOH solution are added to 0.75 per cent. sodium chlorid solution. This gives the monosodium or acid salt, which is slightly irritating when injected locally. Two or three drops of the $\frac{2}{N}$ hydroxid are therefore added; this changes the color to a beautiful Bordeaux red and makes the preparation non-irritant. (The properly prepared solution is now on the market.)

one hour and into a second receptacle at the end of the second hour. In prostatic cases it is wise to have the catheter in place until the end of the observation, the urine being collected, however, as first- and second-hour samples. Each sample of urine is measured and the specific gravity taken. A sufficient quantity of 25 per cent. sodium hydroxid solution is then added to make the urine decidedly alkaline, so as to elicit the maximum color, as acid urine only becomes yellowish or orange, which immediately gives place to a brilliant purple red when it becomes alkaline. The sample is now placed in a liter measuring-flask, mixed thoroughly with distilled water, and accurately filled. A small filtered portion is then taken and compared with the standard used in all these determinations. This consists of 3 mg. of phenolsulphonephthalein diluted to 1 liter and made alkaline by the addition of 1 or 2 drops of 25 per cent. sodium hydroxid solution. This forms a beautiful purplish-red fluid, which retains its intensity of color for an indefinite period, so that a single preparation serves for an immense number of tests. On comparison of the diluted alkaline solution with the standard by means of a Duboscq colorimeter, the percentage of the drug eliminated is readily estimated. The accuracy of this method is shown by the fact that it is possible to detect a difference of 0.04 mg. of phenolsulphonephthalein.

The urinary pigments do not, as a rule, interfere with the colorimeter estimation. If, however, this difficulty arises, it may be overcome by either of two methods: (1) by making up a standard solution containing the same amount of urine as is obtained from the patient, or (2) by precipitating the normal coloring-matter of the urine by basic lead acetate. The former is the more accurate method, as in the use of lead acetate a small amount of the dye is carried down by absorption and cannot be recovered by washing. It is seldom, however, that urinary pigments are present in such a large amount as to cause difficulty in the performance of the test.

Elimination in Normal Individuals.—As the result of the study of 21 normal individuals, Rowntree and Geraghty found that the time of appearance varies from five to eleven minutes, and that 40 to 60 per cent. of the drug was eliminated in the first hour and 20 to 25 per cent. in the second hour, a total elimination of 60 to 85 per cent. in two hours. The excretion of the drug does not run parallel to the excretion of urine: a high output may occur in a small amount of urine and *vice versâ*.

Nephritis.—Other functional tests, as, for example, methylene-blue, indigo-carmin, and rosanilin, although of value in chronic interstitial nephritis, have been useless in acute nephritis and chronic parenchymatous nephritis, in that in these latter conditions permeability has been normal or excessive. Phenolsulphonephthalein is an exception, and herein lies its great value. In acute scarlatinal nephritis Rowntree and Geraghty have found that the dye did not appear, in one case, for twenty-three minutes, and in another for twenty-two minutes, and that the total elimination in the first hour for one of these cases was only 4.8 per cent. In another case of obscure acute nephritis the total elimination was only 38.5 per cent. for two hours. A. B. Eisenbrey and J. H.

Austin,[1] who have made extensive studies in the Department of Research Medicine of the University of Pennsylvania, have found the appearance time to be delayed and the total elimination to be decreased in the experimental nephritides of dogs caused by uranium nitrate, potassium chromate, arsenic, cantharidin, diphtheria toxin, venom, and hemolytic serum.

Rowntree and Geraghty found in chronic parenchymatous nephritis of long duration a distinct decrease in elimination; in those of short duration, however, the change was not so marked and occasionally elimination was normal. On the other hand, in none of 10 individuals with chronic interstitial nephritis was the excretion of the dye normal. In mild cases the highest excretion was 58 per cent. in one hour; in severe cases it fell as low as 3 per cent. in the first hour and 15 in the second, and sometimes only a trace of the dye appeared in two hours. Two individuals with this low elimination died of uremia after, respectively, one and two months. This low elimination is suggestive, therefore, of impending uremia and fatal termination.

In a second communication the discoverers of this test state that they have "found that it is possible to differentiate types of cases in which the renal disease is advanced and is the chief factor in the production of the clinical picture from the cardiovascular renal cases in which the renal condition is a secondary and minor factor."

Pregnancy and Puerperium.—F. C. Goldsborough and F. C. Ainley[2] have used the test as a basis for its application to the study of the toxemias of pregnancy and in the determination of the functional activity of the kidney in pregnant and puerperal women free of definite evidence of renal disease. They found that in the last month of pregnancy the appearance of the dye was delayed, the average for 10 women being 14.6 minutes, as compared with 5 to 10 minutes in normal women; likewise elimination during the first hour was decreased, the average for two hours being only 47.93 per cent., with extremes of 13.8 and 65.7. In only 2 instances did the elimination equal the normal figures of Rowntree and Geraghty. In 11 puerperal women the appearance time was seldom lengthened, and in only 2 was the total elimination decreased. It is evident that the test promises to be of great value in the demonstration of the functional activity of the kidneys in pregnant women, and may eventually play a prominent part in guiding prophylaxis against many of the complications of pregnancy.

Surgical Conditions.—Rowntree and Geraghty have made a special study of the elimination of phenolsulphonephthalein in 53 individuals with hypertrophy of the prostate and obstruction in the lower urinary tract. The results show that in those individuals in which the

[1] A Study of the Elimination of Phenolsulphonephthalein in Various Experimental Lesions of the Kidney, Jour. of Exper. Med., 1911, xiv., No. 5. Acute Experimental Nephritis. A Study of the Elimination of Total Nitrogen and Chlorids as Compared with that of Phenolsulphonephthalein, Jour. of Exper. Med., 1911, xiv., No. 4.

[2] The Renal Activity in Pregnant and Puerperal Women as Revealed by the Phenolsulphonephthalein Test, Jour. Amer. Med. Assoc., 1910, lv., 2058.

obstruction is of short duration and in which the residual urine is small, and also in those leading a regular catheter life, the appearance of the dye occurred as normally or was only slightly delayed, and the total elimination was but slightly diminished; on the other hand, when the condition was of long standing, with a large residual urine, and in individuals not leading a regular catheter life, the time of appearance was markedly retarded and the total elimination was decidedly decreased. Further, and this is of great importance, it was shown that if individuals with the latter condition were placed on the usual pre-operative treatment designed to improve the local condition, the gradual improvement could be followed by the increase in the elimination of the drug.

The conclusions reached are: (1) That a marked decrease in the elimination of the dye contraindicates operation. (2) If under preliminary treatment repeated functional tests indicate a continued low elimination, a chronic interstitial nephritis probably is present; if the disturbance, however, is purely functional or secondary to a pyelonephritis, the time of the appearance of the dye will be shortened and its total elimination increased. (3) The rise of the test enables one to select a favorable time for operation. (4) When the elimination of the drug continues only as a trace, operation should not be attempted at all, except in an emergency, even though the patient presents no evidence of uremia.

Estimation of the Function of One Kidney.—Technic.—Twenty minutes previously to examination 600 to 800 c.c. of water are given the patient in order to ensure a full flow of urine. The ureters are then catheterized, the catheters entering the ureter for a distance of 4 inches. (Catheters with side openings cannot be depended upon; the flute-end catheter of Albarran, No. 6 or 7, was found to be most satisfactory by Rowntree and Geraghty.) A small urethral catheter is now passed into the bladder and the bladder thoroughly washed out, so that leakage, if it occurs, may be detected. The time of the injection of the dye is recorded, as is also the time of its first appearance on either side; the collection is then continued for one hour from the time of the first appearance of the dye. The quantity of urine is noted, as also the specific gravity, and 1 c.c. is taken out for determination of the urea.

In normal individuals the time of appearance of the drugs from the two sides has been almost always the same; occasionally a slight difference of two or three minutes has been noted. The appearance time in the majority of cases has been five to ten minutes. When one kidney only is diseased the time of appearance is delayed and total elimination is not only relatively, but absolutely decreased. In these cases of unilateral disease the time of appearance, however, is not as important as the total elimination. In tuberculosis and renal lithiasis with pyelitis and pyelonephritis the test has been of value. It would seem possible to distinguish between a pyelitis and a pyelonephritis complicating lithiasis. In all cases of tuberculosis the test gave a time-index of the renal condition on both the diseased and on the normal side. In their second communication Rowntree and Geraghty state that data have been col-

lected in 50 cases of unilateral disease, and in no instance has the test been at fault.[1]

Tests made after unilateral nephrectomy, the periods intervening since operation varying from three days to two years, show that a remaining healthy kidney has an elimination capacity of 50 per cent. or more of the normal for two kidneys.

One of the chief advantages of this test lies in the fact that its elimination is independent of that of urea, total nitrogen, etc., and gives evidence of diminished function when other determinations fail to do so. This has been demonstrated by Rowntree and Geraghty in various renal diseases of man, and also by Austin in his study of experimental nephritis in the dog.

Another advantage, offered by no other test, is the opportunity it offers to follow the improvement of functional activity under treatment. This is shown conclusively by Rowntree and Geraghty's study of acute nephritis and obstruction to the lower urinary passages, and also by Eisenbrey in his study of the so-called " spontaneous nephritis" in dogs.

[1] See also E. L. Keyes, Jr., Contribution to the Study of Phenolsulphonephthalein as a Test for Renal Function Before Operation, Amer. Jour. of Urology, 1911, vii., 125.

CHAPTER CXXXIII.

SURGERY OF THE KIDNEY, URETER, AND SUPRARENAL GLANDS.[1]

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In the transplantation of the whole kidney in animals and the securing of efficient blood-supply, as performed particularly by Alexis Carrel, a possible though remote field of usefulness has been opened to surgery. Two years ago he reported experimental work on the grafting of both kidneys with segments of the aorta and vena cava in animals; and in one, at least, the animal was well with apparently perfect renal function eight months after the operation. Other experimenters had transplanted the kidney into the neck, using the blood-vessels of the region for anastomosis, but without success. In the human being, so far as I know, the kidneys of animals have been transplanted only by Jaboulay in 2 cases. In the one the kidney of a goat and in the other that of a sheep was used. The anastomosis was made with the vessels at the bend of the elbow. In both patients the grafted kidney became gangrenous. It is worthy of note that if the blood be washed from the vessels of a kidney to be transplanted, the smaller vessels remain pervious to the blood from the new vascular channels. The most interesting point is the fact that the complete division of the nerve-fibers running to the kidney, such as must of necessity be made in the transplanting of the organ, seems to have little or no influence on the renal function. The physical variations in the amount and density of the urine secreted appear thereby to be proved as due to variations in the general blood-pressure, and to be little, if at all, influenced by the nerves entering the kidney. It is assured by others that there are ganglionic centers within the wall of the pelvis which exercise an independent influence on the caliber of the renal vessels.

It is to be borne in mind that the grafting of kidneys from one species to another is likely to be followed by failure. Hence, the brilliant experimental work alluded to, although of extreme interest and establishing the remarkable technic of the experimenter, must be considered of purely scientific interest, and for the present, at least, can hardly be said to bear on the practical surgery of the kidneys in human beings.

The Multiplicity of Renal Arteries.—Until the increasing frequency of operations on the kidney made the origin, number, and

[1] Supplementary to Chapter LVI., Vol. IV., p. 183.

distribution of the renal arteries of surgical importance, very little attention was given to the subject. Israel long ago described a hemorrhage that was nearly fatal from an accessory artery, but it attracted little attention. In ruptures of the kidney, where resection may be practised, in tuberculosis limited to one pole, and particularly in cases of hydronephrosis, the variation in the number and distribution of the renal arteries plays quite an important rôle. The largest statistical investigations on the cadaver have been made by Brewer, and, more recently, by Seldowitsch. In 151 bodies examined by Brewer there were 85 kidneys having more than one artery: 12 had three arteries, 2 had four arteries, 1 had five arteries. Seldowitsch found an anomalous arterial distribution in 43 subjects out of 150. There is a slight preponderance in favor of the left kidney. In regard to the origin of accessory arteries, it may be stated that they may spring from any portion of the aorta below the primary renal artery or from any of the large trunks. The distance between the vessels at the point of origin may be considerable, varying from 4 to 10 cm. Where there are two arteries, they both enter the hilum of the kidney in a little over one-half of the cases (27 out of 50). One of the arteries always enters at the hilum. The accessory artery enters the lower pole of the kidney twice as often as the upper. In only 10 of the entire number of subjects examined was a double renal vein found. Of very great importance are the relations of the accessory artery. In 17 out of 43 cases the ureter passed in front of the lower accessory artery, when the distance between this and the main trunk was considerable. But, where the arteries were close together, the ureter was usually surrounded by the branches of the accessory vessel. When it is considered that the accessory artery is not infrequently almost as large as the main trunk, its bearing on operations near the upper end of the ureter or the renal pelvis is self-evident. In exploring the pelvis of the kidney, and particularly in severing adhesions, the operator may believe himself safe because his manipulation is away from the renal vessels. A sudden severe hemorrhage may arise from a severed accessory artery. Since these vessels are often as large as the radial, pulsation should be felt for in every suspicious strand before division.

Although, so far as I know, in none of the anatomic findings was hydronephrosis associated with low-placed accessory arteries, it seems certain now that their relation to the development of hydronephrosis is more than accidental. Ekehorn collected 25 operative cases of hydronephrosis which were due to angulation of the ureter near an accessory artery. Those accessory arteries, which after passing behind the ureter pass on to the anterior surface of the kidney or the anterior lip of the hilum, are particularly likely to be associated with hydronephrosis. In the same way those passing in front of the ureter and ending in the posterior surface of the kidney, or in the posterior lip of the hilum, have a tendency to produce hydronephrosis. It is evident, from what has already been said, that an accessory artery cannot *per se* produce a hydronephrosis. Given, however, the conditions which

tend to displacement of the kidney, the accessory artery may become the immediate cause of dilatation of the renal pelvis (Mayo).

For practical purposes the renal arteries may be considered end arteries, in that they form no anastomoses. With the exception of a few small branches passing upward to the pelvis on the ureter and some small vessels entering from the capsule, the renal artery is the sole supply of the kidney. Tying the renal artery does not, therefore, destroy the entire kidney, for certain small areas may remain intact. These are so small, however, that, so far as the function of the gland is concerned, they might as well not be preserved. Since decapsulation of the kidney has been brought forward as a cure for chronic Bright's disease, this terminal arrangement of the renal arteries is important in determining whether by decapsulation new blood-vessels would be formed through the new capsule from blood-vessels other than the renal. Experiments have been made by many, notably Parlavecchio, Tuffier, Liek, and others. During the past year J. Louis Ransohoff and I, in a dozen experiments on rabbits, have transplanted the kidney in the omentum after tying the renal vessels with a view to corroborate the results of the Italian school. Autopsies revealed that in no instance was the kidney enabled to functionate and in most instances it had undergone necrosis. The omentum in which the kidney had been embedded was in every instance very much thickened, and contained many and relatively large venous plexuses. The effort to utilize the omentum in the living being was first suggested and practised by Bakes. He enfolded the kidney in the omentum in a case of Bright's disease, but his patient succumbed on the third day. Gelpke more recently reported 3 operations with a view to establish an anastomotic circulation, and claimed to have obtained an improvement in each of his cases of chronic Bright's disease. It is unfortunate that experiments with a view to establishing an anastomotic circulation are made under conditions totally different from those in which it is aimed to establish it in cases of Bright's disease. Except in the arteriosclerotic cases the disease is toxic and chronic in its nature, and it has thus far been impossible to produce a chronic nephritis in animals.

Means and Methods of Examination.—While no new methods of determining the total function of the two kidneys or of the functional capacity of each one separately have been devised since the publication of my original chapter (Vol. IV., p. 183), certain of them have been very materially improved. This is particularly true of ureteral catheterization with lead- or bismuth-containing catheters. Ureteral catheterization seems to be displacing the segregator, since the latter cannot yield the accurate information obtained by the former. There must always remain, however, a considerable number of cases in which ureteral catheterization is impracticable, and the examiner must be content with a cystoscopic examination plus the use preferably of indigo-carmin. If 4 c.c. of a 4 per cent. solution of indigo-carmin is injected into the gluteal region, the urine excreted should appear blue in from ten to fifteen minutes. With a cystoscope in place five or six minutes

after the injection, the ureteral openings are relatively easily found even in diseased bladders by the whirls of the colored urine. A delay of more than ten or fifteen minutes speaks for impaired function, provided that there are clinical data bearing that way. The value of chromocystoscopy must always be that of an adjuvant to diagnosis, since even in health there are wide variations, both as to the time of appearance of the color in the urine and as to its intensity. It is well known that under the stimulus of ureteral catheterization the excretion of the two kidneys may vary both in quantity and in composition. Wherefore, Thomas rightly concludes that chromo-ureteroscopy should be made without ureteral catheterization. His conclusions are derived from an examination of 70 cases, in 30 of which the kidneys were normal, and in 40 were diseased. In persons with normal kidneys the dye makes its appearance at the same time on both sides in about 75 per cent. of the cases in from five to fifteen minutes. Where there has been a variance, it has ranged from one to seven minutes. The shade of the stain is of value, since in renal insufficiency the stain may be either entirely absent on the affected side, or, if present, be of a light blue. The conditions in which the indigo-carmin test is of the greatest value are hydronephrosis, multiple calculi, intrarenal suppurations, tuberculosis involving at least one-third of the renal parenchyma, and ureteral stenosis. According to Thomas, the conditions in which the test is of little or no value are movable kidney of slight mobility in which there is no kinking of the ureter, nephritis, pyelitis, and tumors not involving a majority of the parenchyma. However, in the last two the presence of pyuria, and especially in the last, in the absence of tuberculosis, calculus, or renal papillary varices (essential hematuria) the appearance of free bleeding from the ureter may establish the diagnosis on sight. During the past year Rowntree and Geraghty have used phenolsulphonephthalein for determining the functional activity of the kidneys. It may be administered by mouth or under the skin in doses of 6 mg. to the cubic centimeter. In normal individuals it appears in the urine in ten minutes. It has been quite extensively used by B. A. Thomas with very satisfactory results.

When catheterization is practised great care is needed lest false conclusions be drawn. It must first be borne in mind that the mere presence of a catheter produces a polyuria, which may be so profuse for two or three minutes that one may think of retention within the renal pelvis. The product of this reflex hypersecretion is very pale and of light specific gravity, and not at all like the ordinary urine. If the first urine obtained flows freely and resembles the normal urine in color and specific gravity, there should at once be a suspicion of renal retention. The capacity of the normal renal pelvis does not exceed 2 or 3 c.c., and in the healthy kidney even this is not all utilized for storing urine. In this connection allusion may be made to the common experience of the mortuary; namely, that at autopsy the pelvis of a normal kidney contains practically no urine. This is also shown by the fact that if the ureteral catheter is pushed into the pelvis the urine drips out continu-

ously; whereas, if the tip of the instrument is passed into the ureter for 3 or 4 inches only, the urine appears in successive spurts of from 8 to 10 drops, each with intervals of pauses varying from six to eight or nine seconds. With the catheter in the ureter, there may be an obstruction to the flow of urine caused by a minute traumatism or by a plug of pus. The injection of sterile water into the catheter will readily overcome this. The first urine removed by ureteral catheterization will very frequently

Fig. 305.—Pelvic Phlebolith Removed by Operation. Catheter in Ureter.

contain some blood-cells from traumatism, wherefore the first flow must not be regarded as the average urine of the kidney under investigation. In not a few instances the mere presence of the ureteral catheter causes a reflex anuria, which usually disappears after a lapse of ten to fifteen minutes.

When both ureters are simultaneously catheterized, catheters of different colors should be used or they should be marked in some way, lest there be some uncertainty as to the kidney to which each catheter belongs.

The value of renal catheterization can be greatly enhanced by combining it with radiography. This applies particularly, as was already pointed out in my original chapter, to ureteral stones. By the use of a catheter impregnated with lead or bismuth a differential diagnosis can almost always be made between ureteral stone and a concretion outside of the ureter, such as appendical stone and phleboliths of the pelvic veins. Fig. 305 is taken from a case of the kind in question. The patient, forty years of age, had been suffering for a number of years from what seemed to be attacks of renal colic associated with vomiting. A prolapsed kidney was believed to exist, and the attacks of colic were believed to be due to ureteral kinking. Ureteral catheterization showed a normal kidney and no obstruction to the entrance of the catheter. The first *x*-ray picture showed a stone which seemingly was

FIG. 306.—STONE IN PELVIC PORTION OF URETER, PASSED INTO BLADDER. (See Fig. 305.)

in the ureter. With a leaded catheter in position, the stone was shown to be fully $\frac{1}{3}$ inch away. An operation revealed veiled adhesions about the appendix and the cecum which produced intermittent obstruction. The stone was easily brought into the wound and removed from a pelvic vein. It must, indeed, be a very rare case in which the shadow of the catheter would directly overlie another shadow which was not produced by a stone within the ureter itself. It is here that careful and frequent examination of the urine is a most valuable aid in the differential diagnosis. Although stones in the ureter, as in the kidney, may be symptomless for long periods, they will make themselves manifest by changes in the urine. This is well shown by a case reported by Brewer in which there were no urinary symptoms. There was a distinct shadow on the *x*-ray plate in the left half of the pelvis. The history does not state

whether a leaded catheter was used. The ureter was exposed, opened, and found normal. The shadow was caused by a calcified epiploic appendix of the sigmoid adherent to the parietal peritoneum over the ureter.

A number of radiograms should be taken in certain cases, as of dilatation of the pelvis, and particularly of stones within the ureter before operation. Wherever possible a radiogram should be taken before operating, for a relatively small ureteral stone may pass a few hours before operation. Figs. 306, 307 will illustrate this. The patient had been suffering from symptoms of ureteral stone for a number of months. A

FIG. 307.—STONE IN BLADDER, PASSED PAINLESSLY FROM URETER. (See Fig. 306.)

radiogram (Fig. 306) showed the stone in the pelvic portion of the ureter. A day was fixed for operation ten days after this picture was taken. The evening before the operation a second picture was taken (Fig. 307) which showed the stone centrally placed. A cystoscopic examination showed it had entered the bladder, whence it was easily removed by litholapaxy. Its passage through 2 or 3 inches of the ureter had caused no pain. Had the second picture not been taken, a needless operation would have been performed, the search for the stone in the ureter would of necessity have been very prolonged, and, of course, in vain.

With the perfection of *x*-ray technic, it is now possible in many sub-

jects, and that by short exposures, to obtain shadows of the kidney itself. When the large intestine is filled with bismuth the *x*-ray will show its relations to the kidney, and thus be of help in distinguishing enlargements of the kidney from those of contiguous organs. Fig. 308 shows a normal kidney and Fig. 309 one that is very much enlarged and displaced downward.

Suppurative Lesions of the Kidney.—Since the publication of the original chapter, some new facts, both clinical and experimental, have been gleaned as to the method of the development of suppurative lesions.

FIG. 308.—NORMAL KIDNEY OUTLINE IN DEEP INSPIRATION.

Practically all renal suppurations are due to an ascending process from the lower urinary tract or are the result of infection from the blood-current. With the more frequent use of cystoscopy, and particularly of ureteral catheterization, especially in the hands of beginners, cases of severe infection of the kidney as a direct result of such examinations are becoming more numerous. The first case, as is well known, was reported by Israel, and Berg has recently reported one in which nephrectomy had to be performed as a life-saving measure. I am familiar with another case in which a cystoscopic examination by an expert in a case of contracted bladder was directly followed by a grave pyonephro-

sis. Although, in comparison with the number of examinations made, infection of the kidney by ureteral examination is rare, its possible occurrence must, nevertheless, be considered in every case in which the examination must be made through an infected bladder.

It has long been known that a healthy bladder can take care of virulent micro-organisms, provided there is no obstructive lesion. If this obstruction is produced by experiment on animals or by some lesion, such as an enlarged prostate, ureteral stricture, or stone, an ascending infection readily takes place. The oblique passage of the intravesical portion of the ureter through the bladder wall is an effective barrier within wide limits of ascending infections. The greater the distention

FIG. 309.—LOW ENLARGED KIDNEY-PYONEPHROSIS.

of the bladder, the more securely the infection is kept from the ureters. It is only when the ureteral openings are deformed that infection follows. In other words, the micro-organisms, if motile, ascend, and in the contrary case are carried upward to the kidney in the column of urine within the ureter. While in exceptional cases the ureters show evidences of infection, in a great majority the mucosa of the excretory ducts is uninfluenced by even prolonged contact with the infected urine.

In the original chapter attention was already called to the possibility of infection of the lymphatics around the kidney, and particularly of the renal pelvis by extension of infective processes from around the bladder by way of the retroperitoneal lymphatics. Brewer has recently reported

a case in which the infection ascended by both routes and terminated fatally within ten days. At the autopsy a large gangrenous slough was found in the region of the trigonum. The left ureter and peri-ureteral tissues were very edematous and the right kidney destroyed by purulent infection. According to a number of experimenters, the lymphatic route is the more important one in upward extension of infections to the kidney. L. F. Stewart transplanted ureters of dogs into the bowel, and in a number of instances produced infection of the perirenal tissues with entire absence of changes in the kidney. Again, cortical abscesses are produced in this way without involvement of the pelvis. While these experiments, as well as the study of the lymphatics of the bladder and kidney by Sakata and Kumita, establish the possibility of such infections occurring, from a clinical view-point, as has already been stated, the infection, as a rule, ascends within the ureter.

The conditions in the lower urinary tract on which an ascending infection of the kidney may follow are varied and, as a rule, obstructive. A maltreated stricture of the urethra, a neglected or hypertrophied prostate, a stone or tumor of the bladder, are among the commoner causes. The suppurative lesions of the kidney so often observed in the terminal stages of spinal cord degenerations are also due to functional deteriorations of the musculature about the ureteral openings. In very rare instances an acute cystitis is followed by rapid involvement of the kidneys. It is remarkable, however, that at least in young persons the most common cause of cystitis, namely gonorrhea, is rarely followed by extension to the kidneys. It is probable that without involvement of the bladder an ascending gonorrheal infection cannot occur. On the other hand, since it is well established that the gonococcus alone or associated with other bacteria can cause inflammatory changes and suppurations in parts of the body far removed from the urethra, it is possible that in deep-seated suppurations of the kidney due to the gonococcus the infection is hematogenous in character. In a very able article, in which he reports 2 cases of his own, 1 of which died, Nixon comes to the conclusion that, excluding cases associated with general septicemia, there have been only 12 authentic cases reported, of which 6 were pure and 6 were mixed. As might be expected, the condition occurs more frequently in men, owing to the greater prevalence of the primary affection in them. From his studies it would seem that the hematogenous infection always plays a more important rôle than the ascending type. To justify the diagnosis it is necessary to demonstrate the gonococcus in the kidney itself or in the separated urine. Altogether Nixon could collect only 13 cases (exclusive of his own), of which 10 were in men. The right kidney was involved eight times; the left, three times; both kidneys, twice. In the cases of gonorrheal pyelitis the renal symptoms usually appeared between the sixth and twelfth weeks. In one case they appeared as early as the tenth day, and in another as late as the tenth month. Under lavage of the renal pelvis, or by internal medication alone, the symptoms invariably cleared up within a short time.

Including Nixon's 2 cases from the Johns Hopkins Hospital, there were 5 of pyonephrosis; 2 of them died and 2 recovered after nephrotomy. In the fifth case, one of Nixon's, a nephrectomy was performed, the outcome of which, however, is not stated.

Suppurative lesions of the kidney are, for the most part, hematogenous in character. This being true even in cases of calculous pyelitis, where the stone was the primary lesion, an infection occurred later from the blood-stream. The sources and variety of the infection naturally vary greatly. When we consider that normally the kidneys excrete bacteria demonstrable in the urine in very large numbers, it is remarkable that suppurative lesions are not oftener found. It is to be remembered that according to Howell 5 per cent. of the total quantity of blood in the general circulation passes through the kidneys within a minute. Probably this very free circulation is protective. Bacteriuria frequently exists without implication of the kidneys; 20 to 25 per cent. of typhoid patients have it, and in pregnant women, according to Dudgeon, 9 out of 45 had the colon bacillus in their urine without demonstrable symptoms. As in other grave deep-seated lesions, so for those of the kidney, we must now look for some earlier infection of greater or less severity as the primary source of the renal suppuration. The acute exanthemata, furuncles, superficial infected wounds, and particularly acute infections of the tonsil have been found as precursors of renal suppuration. With this underlying condition, a slight trauma in the region of the kidney, excessive functional activity, the presence of a stone or even temporary retention from any cause, will suffice to induce grave suppuration in the kidney. Since the first experiments by Albarran of renal infection many studies of like nature have been made, notably by Pernice and Scagliosi, and more recently under Brewer's direction. They all show that the injection of a moderate dose of pathogenic bacteria into the circulation does not damage the kidney. In Brewer's experiments 11 out of 16 animals, which in addition to the inoculation received an injury to one kidney, developed distinct surgical lesions of the kidney; and in 8 of them the lesions were unilateral and limited to the injured kidney. In 3 the lesions were bilateral.

The experiments thus bear out the observations long made by clinicians that suppurative lesions of the kidney, hematogenous in character, are, as a rule, unilateral and subject to even most radical operative interference, provided that the kidney on the opposite side is functionally competent. Indeed, it may be asserted that by relieving a unilateral renal suppuration we are safeguarding a sound kidney against like infection.

Acute Unilateral Suppurative Nephritis.—In very exceptional cases a very grave unilateral infection of the kidney, resulting in many small infarcts and multiple abscess formation, follows slight maladies like bronchitis, grip, tonsillar infection, and after an operation. The infecting agent has almost always been found to be the colon bacillus. The infarcts are invariably situated in the cortex directly underneath the capsule and are irregularly distributed. Woolsey reported one of

staphylococcus infection limited to the lower pole and in which he successfully performed resection. The case, however, was subacute in character. There were a number of cortical abscesses. In the milder type of renal suppurations there is time to establish a diagnosis, since the symptoms are progressive, permitting the use of all the modern methods of functional renal diagnosis. In the grave cases, however, which are fortunately rare, as has been pointed out by Brewer, either on account of the great virulence of the infecting organisms or because the invasion of the kidney is immediately attended by a toxemia so intense that the local symptoms are largely overshadowed by those of the general toxemia, functional tests cannot be made. As Brewer pointed out, these cases are often so acute and progress so rapidly that death may ensue before the distinctly renal symptoms manifest themselves. From the beginning the sepsis is pronounced, the condition often being initiated by a severe rigor. A high temperature, rapid pulse-rate, and rapid breathing may lead one to think of lobar pneumonia or a severe grip. Fortunately, as a rule, a more or less vague pain in the loin on the side of the lesion points to involvement of the kidney. The condition might easily be mistaken for acute appendicitis or infection of the gall-bladder. The mixed urine often seems normal, the light traces of albumin, of blood, or of pus being unnoticed unless a very minute examination be made. A pathognomonic sign of the condition present in all the cases is an extreme sensibility to pressure over the costovertebral angle and muscular rigidity. In nearly all cases a very high leukocytosis (24,000 to 36,000) has been encountered. In a number of cases the condition was only recognized after an operation for suspected appendicitis revealed a normal appendix.

If left alone these acute unilateral infarcts almost invariably are fatal, with or without involvement of the opposite kidney, although Cobb recently reported a case in which recovery ensued after an exploratory operation had to be abandoned on account of the desperate condition of the patient. Brewer reported 14 cases of this kind, of which 2 received no treatment and died in twelve days; 4 were treated by nephrotomy and drainage and died a short time after the operation; 8 were treated at once by nephrectomy and all recovered. This is in accordance with the view expressed by me in regard to the relative dangers of nephrotomy and nephrectomy in suppuration of the kidney, although in ordinary suppurative lesions of the kidney the discrepancy in results between nephrotomy and nephrectomy are nothing like that experienced by Brewer in the management of the acute hemorrhagic infarcts. That nephrectomy is not necessary in every case is shown by recoveries following capsule splitting and drainage; 2 cases were reported recently by Cotton and 2 by Cobb.

Perinephric Suppurations.—In addition to the usual causes of abscesses in the perinephric fat, such as stone, tuberculosis, or pyonephrosis, cases are multiplying in literature in which suppurations develop in consequence of peripheral suppurations seemingly of slight importance. Furunculosis, carbuncles, and felons have been particu-

larly known to be followed by perinephric abscess. These abscesses are always the result of cortical metastases directly under the fibrous capsule of the kidney, through which they break and, in turn, infect the fat capsule. Rehn has recently reported 8 of these cases. In a tabulation of 36 cases collected from the hospitals of Philadelphia by Miller, the source of infection was unknown in 20 cases. It is more than likely that of these a number were due to overlooked slight peripheral sources of infection.

In these cases the operation, which should be performed early, reveals an adherent fat capsule with, usually in the early stages, a small abscess, which communicates through an opening in the fibrous capsule with a small suppurating lesion of the renal cortex. This latter is so characteristic in its appearance that Israel has given it the name "kidney furuncle" or, better, "renal furuncle."

The characteristic symptoms are a sudden onset without any previous symptoms of a renal affection. Intense pain and tenderness in the renal triangle and the absence in the urine of evidences of renal implication. This is easily explained by the fact that unless the metastatic renal abscess breaks into the pelvis the urine will not reveal its presence. A further diagnostic point is the very high leukocytosis usually found in perinephric suppuration, the general average being 24,700 (Miller). In pyelonephrosis the leukocytosis is very much lower.

Tuberculosis of the Kidney.—With the increasing ease with which tuberculosis of the kidney is recognized in its early stages, its frequency seems to be increasing. Thus, Kroenlein showed that nearly 30 per cent. of all surgical diseases of the kidney are tuberculous. When it is considered that in the terminal stages of tuberculosis little remains but a pus-sac obliterating all traces of the tuberculous process, it may be safely asserted that over half the suppurative conditions found in the kidney, when a stone is not found, are due to tuberculosis. Its unilateral nature in the beginning has been firmly established, and even when death occurred from renal tuberculosis, one kidney was found sound in 67 out of 191 cases (Kapsammer). That the disease begins in the parenchyma has been shown by the fact that no cases have been seen by operation or autopsy in which the disease was limited to the pelvis, ureter, or bladder. In rare cases a slight trauma or prolonged irritation from a stone may be the exciting cause of tuberculosis of the kidney. The following case is illustrative:

Edwin C., aged thirty, was seized with severe pains on right side of the kidney with fever and chills ten weeks before he consulted Dr. Hoppe, who referred him to me. At times before the present illness the patient suffered from occasional attacks of severe pain in the right loin for a number of years. During his acute illness he lost 35 pounds. The chest examination by Dr. Greiwe revealed an anemic bruit at the base, and a slight tuberculous involvement of the right apex. The blood-count, 12,500 leukocytes, 4,000,500 reds; hemoglobin, 50 per cent. There was exquisite tenderness over the right kidney and some fulness. Urinalysis showed light-colored urine; specific gravity, 1020; a considerable amount of pus, red cells in every field, no casts. The cystoscope showed redness about right ureteral orifice. Catheterization of right ureter showed urine containing slight trace of albumin, some red and white cells, and a few tubercle bacilli. The *x*-ray revealed a shadow in the pelvis of the right kidney.

The operation performed at the Good Samaritan Hospital, May 19, 1908, revealed a uric-acid stone in the pelvis of the right kidney. The kidney was firmly bound down about the hilum so that it could not be delivered into the wound. The capsule measured fully $\frac{1}{12}$ inch in thickness. On the outer side of the capsule in the region of the hilum there were typic caseous deposits varying in size from a pea to nodules the size of the end of the little finger.

It was doubtless a case in which the presence of a stone in the pelvis in a tuberculous subject led to tuberculosis in the pelvis of the kidney, and a limited infection conveyed through the wall of the pelvis to the fatty tissues on the outside. In the course of time, had an operation not been performed, there would doubtless have developed a perinephric abscess and probably a renal fistula.

Clinical experience and experimental research inaugurated by Baumgarten have shown conclusively that tuberculous infection is conveyed in the direction of the secretion from the part primarily infected. The course of the infection is from the kidney to the bladder or from the testicle to the prostate and bladder, thus making the bladder a sort of neutral ground. It cannot be questioned, however, that in whatever way the bladder becomes secondarily involved, the disease may extend upward to a sound kidney, either through the column of urine within the ureter or through the lymphatics, as previously stated.

In **diagnosis** but little has been added to the facts set forth in my original chapter. Changes in the urine are of the utmost importance, for except in very rare cases in which the lesion in the kidney does not in any way communicate with the pelvis, pus and occasionally blood will always be found in the urine, which remains for a long time acid. If the tubercle bacillus is not found it is probably because the examination is too superficial. Large amounts of urine may have to be collected and centrifuged repeatedly before a few bacilli are found. As Ekehorn has stated, "numerous bacilli may be found in the urine in very early cases and their number vary greatly during different periods of the disease. With every involvement of a new part of the kidney the bacilli become more numerous. With numerous bacilli there may be a small quantity of pus, and with a large amount of pus the bacteria may be relatively few in number." The older the lesion, in other words, when secondary infection has made a pus-sac of a tuberculous kidney, the pus is large in quantity and it may be difficult, almost impossible, bacteriologically to make the diagnosis of tuberculosis. The gross examination of such a kidney, even after operation, may fail to reveal tuberculosis as the primary cause of the disease.

In the **treatment** of tuberculosis of the kidney a word must be said in behalf of the climatic and constitutional care of these cases. In the extremes of the disease much may be accomplished in this way. In the very early cases, particularly where the symptoms are slight, a radical operation may be properly postponed until the treatment alluded to has been given a fair trial. Every now and then a cure will be effected. That this is not impossible is shown by the occasional appearance at autopsies of cured cases of tuberculosis of the kidney. In the very extreme cases, where both kidneys have already been involved, climatic changes with palliative operations may likewise add to the length of life and the comfort of the patient.

In the great majority of cases nephrectomy still remains the operation of choice, and wherever feasible the ureter should be removed with the kidney. It is my experience, like that of most operators, that the earlier the nephrectomy is performed and particularly if done before the bladder becomes much involved, the more favorable is the prognosis. Tuberculosis elsewhere, if not too far advanced, does not contraindicate operation, and particularly is this true of the involvement of the bladder. Nephrotomy, except as a palliative operation for secondary pyonephrosis, when nephrectomy is inexpedient, has no place in the treatment of renal tuberculosis. It is almost certain to be followed by a renal fistula, which will yield only to a nephrectomy.

Partial resection, except where the one kidney had been previously removed, has been practically abandoned. Quite recently Delbet and DePaoli have again called attention to the dangers of resection in these cases.

Essential hematuria continues to be an enigma as to its nature, although the cases are multiplying in which some small but positive vascular lesion of the kidney has been found to exist as the underlying factor. In many cases there is a diffuse glomerulonephritis. Fenwick was the first to call attention to the presence of capillary nevi of the papillæ as the cause of painless hematuria, and reported 3 cases. Pilcher reports 2 cases in which he believed this varicose condition of the papillæ caused the hematuria. In almost all of these cases the hematuria is unilateral. Schwyzer operated on 5 men with hematuria, the site of the bleeding being first determined. In each case portions of the kidney removed showed changes seemingly due to trauma. All of the cases were cured by splitting the kidney.

Bunts, in a tabulation of 70 cases, found that in 18 the kidney was apparently normal. In the treatment of this condition operation is indicated, and a choice must be made between nephrotomy and nephrectomy in most of the cases. In a few the fixation of an unsuspected movable kidney was curative. In 6 recorded cases the opening of the pelvis and the removal of the papilli was curative. Of 20 cases where nephrotomy was done, a cure was effected in 19, and death occurred in 1. In 3 cases a secondary nephrectomy became necessary. An interesting case of this kind is that of Bell, in which the kidney was removed twenty-two days after nephrotomy. The bleeding continued and made nephrectomy necessary. She was reported well six years later. The kidney showed no changes except such as might fairly be attributed to the previous operation. Of 11 nephrectomies, 1 was fatal. The proportion of cures which has followed either nephrotomy or nephrectomy is so large that, for the treatment of this condition, operation is positively indicated, nephrotomy being the procedure of choice.

Renal Calculus.—As has already been intimated, the case must be a very unusual one in which a positive or negative diagnosis of stone in the kidney or ureter cannot be made. In very fleshy subjects it is possible that a failure to show a stone may be encountered. In all others the nature of the stone may often be suspected from the density

of the shadow. In every good plate there should be shown, besides the stone, the outline of the kidney. Contrary to expectation, the latter is more readily elicited in radiograms of adults than of children. Parenthetically it may be stated that in the best plates gross structural changes of the kidney may be seen; multiple abscesses and cysts having been recognized, and even a suspicion of tuberculosis aroused.

The treatment of nephrolithiasis presents little that is new. The question as to whether a calculus once formed in the kidney can be absorbed, has been solved affirmatively by experiment. Rosenbach, following in the wake of Tuffier's researches, introduced into the renal pelvis of dogs oxalate stones varying in size, some of them measuring 11 × 8 × 6 mm. The largest in one experiment measured 25 × 8 × 9 mm. In from six weeks to three months the autopsies, as a rule, revealed little or no trace of the stones that had been embedded. The author concludes that the solvent power of a healthy kidney on a stone is very considerable, and believes it to be due to the solvent action of the urine on the organic cement substance, which holds the inorganic components of the stone together. I recently crushed a phosphatic stone in the bladder in a patient to whom methyl-blue had long been administered. The stone, although it weighed 120 grains, was tinged a light blue throughout. In another patient with calculous pyelitis, small stones passed from time to time were permanently colored. It is certain, therefore, that the process of imbibition through the colloid framework of the stone can invade the latter quite to its center. Nevertheless, a solvent for stone remains to be discovered, however great a bearing these data may have on the future therapy of calculous disease. Operation is, therefore, the rational and routine treatment of kidney stone as soon as it is evident that the stone cannot be passed, and before serious damage results to the kidney. When the stone is in the ureter and is small, efforts may be made to dislodge it by injections into the lower ureter through the ureteral catheter. The cases are multiplying in which an operation has been made unnecessary by these means. With appropriately constructed ureteral forceps small impacted stones have also been removed (Bransford Lewis). The necessity of taking a number of radiograms, particularly before operating for ureteral stone, has already been mentioned.

Anuria, the most serious complication of kidney stone, has received much attention. It has been firmly established that a calculous obstruction of the ureter of one side can by renorenal reflex inhibit the function of the normal kidney of the other side. Although this is rare, the instances are multiplying. The important thing to remember in this connection is that in very many cases both kidneys together possess functional activity sufficient to sustain life, but in which neither one alone is equal to the task of adequate secretion. This was well illustrated in a case reported by me in 1895, of a young man in whom there was no anuria at the time the patient was subjected to a right-sided nephrolithotomy. There was a pyonephrosis, but the kidney was still able to perform a very considerable work. It was

drained. Both kidneys continued to secrete for the next month. At the end of this time the other kidney became obstructed and anuria followed. Thirty-seven days after the first nephrotomy the second kidney was opened and found to be pyonephrotic. Both kidneys at once resumed their function, and within twenty-four hours the patient was on the road to recovery. The first kidney operated upon performed two-thirds and the second kidney one-third of the total functional work of secretion. In this patient a secondary operation for stone was performed six years after the first operation. The statement of Legueu has often been disproved; namely, that anuria does not occur except in patients who live with only one kidney. Indeed, it is impossible with our present knowledge to state to what extent a defective kidney may resume its function after it has been relieved of acute changes due to obstruction. In cases of anuria it is often remarkable how long there may be an absence of uremic manifestations and a condition of comparative well-being exist. As is well known, Polk's case lived eleven days after the only kidney was removed. Cases of recovery from anuria have been described after ten days or more. Quite recently W. D. Minningham reported a case in which a woman with only one kidney was operated upon for pyonephrosis and recovered after twenty-three days of total anuria; 500 c.c. of thick, foul-smelling pus were evacuated and four phosphatic stones were removed, one of which was with difficulty extracted from the upper end of the ureter.

Since calculous disease is bilateral in about 30 per cent. of all cases, it cannot be rare for the blocking of the ureters to be bilateral and simultaneous. Watson collected 187 cases, of which 52 were bilateral, and in 29 of these there was silmultaneous blocking of the two ureters. It is in such cases that a simultaneous nephrotomy on the two sides may have to be done. In treating anuria caused by Bright's disease and of puerperal eclampsia, reference will be made to the intravenous injection of large quantities of Fischer's solution of sodium chlorid and bicarbonate of soda. It will also be possible in individual cases, although they must of necessity be rare, to relieve the obstruction by ureteral catheterization. Unfortunately, as I stated in the original chapter, as a rule, it is impossible in these cases to do more than obtain *x*-ray examinations, and the condition of the patient is often such that very speedy interference by operation becomes a matter of life and death. When to operate on both kidneys is a difficult problem to solve; although if the operation on the first kidney reveals an amount of renal substance which makes it improbable that it of itself is sufficient to sustain life, the other kidney ought likewise to be exposed and nephrotomized.

Hydronephrosis.—In the causation of hydronephrosis obstruction in the ureter from such causes as stone or stricture and of kinks in the upper part of the ureter by anomalous blood-vessels or looseness of the kidney play the important rôle. Particularly Mayo has found the anomalous blood-vessels a common cause of hydronephrosis, it being present in 20 out of 27 cases. Injury is a common cause of acute hydronephrosis, and a sudden blocking of the ureter or of a complete

transverse rupture may produce it. An interesting case of this kind was reported by Bell. The view, entertained until quite recently, that hydronephrosis is usually the result of a chronic obstruction needs modification. By some recent experiments, notably those of Scott, by tying the ureter, it has been shown that the accepted view, that hydronephrosis can result only from chronic or intermittent obstruction, is no longer tenable. In 12 dogs in which the ureter had been tied, hydronephrosis of high degree was produced. Extraneous pressure as from tumors occasionally produce hydronephrosis, although this applies rather to the hydronephroses seen at autopsies than to those encountered clinically. A localized hydronephrosis limited to one pole

FIG. 310.—PYONEPHROSIS INFLATED WITH AIR. (Cole.)

of the kidney has occasionally been found as the result of a stone impacted in one of the calices or of a tumor in the same locality. Dilatation of the ureter above a stone is present in half the cases, although when the stone is guttered such dilatation may not result. In the diagnosis much may be learned from ureteral catheterization, particularly when it is combined with the injection of a 2 per cent. solution of collargol and radiography. Cole, of New York, has recently used air or collargol with excellent results (Fig. 311).

The treatment of hydronephrosis is largely that of removing the cause. If, when this is accomplished by the removal of a stone, the fixation of the kidney, or the division of an anomalous blood-vessel, the

hydronephrotic condition still remains, a plastic operation, such as is described in the original chapter, will have to be performed. When in cases of long standing the valve-like condition exists at the ureteropelvic juncture, the classic operation of Fenger may be done at once. As time progresses and diagnoses are made earlier, nephrectomy for hydronephrosis should become less frequently necessary. Surely no kidney should be sacrificed until one or more efforts have been made to save it by plastic procedure. Drainage should always be used to prevent infection in case of leakage, but gauze of any kind is here out of place, lest in removing it the sutures be drawn upon. A few strips of rubber tissue answer the purpose admirably.

FIG. 311.—PYONEPHROSIS INJECTED WITH COLLARGOL. (Cole.)

Cystic disease of the kidney continues to be, for the most part, a *noli me tangere*. The disease almost always involves both kidneys and is practically always congenital. It is remarkable that life may continue for many years with so little of the secreting structure of the kidney left. In a case reported by Bovée the patient, twenty-nine years of age, gave birth to a normal child sixteen days before death. John S. Neate estimated the functional renal tissue of each kidney at about 1 cubic inch. In a case that recently came to autopsy in the Cincinnati Hospital both kidneys were very much involved, had hundreds of cysts in them, the contents of which varied greatly in different parts. Except for the discomforts incident to the enormous tumors,

which measured 11 inches in length, the woman was well. Death resulted from anuria. In a specimen recently presented to the museum of the Cincinnati Hospital removed from a still-born child each kidney was as large as the normal adult organ, and on section presented finest honeycombed appearance.

As to the cause we are in the dark. Persistent germinal rudiments and obstruction of the tubules from prenatal sclerotic processes are among the explanations given for the condition. The first theory is probably the usually applicable one. Since the pelvis of the kidney and ureter are formed from the Wolffian body, and the excreting portion from the metanephric blastema, a failure of the two parts properly to unite explains the condition and why the disease is practically never unilateral. Associated developmental anomalies are far from rare and heredity plays quite an important rôle. Sänger (quoted by Bovée) reports having observed a family in which the first, fourth, seventh, tenth, and thirteenth child had bilateral congenital cystic disease of the kidney, the other children being normal. Although the disease is so often congenital, it, as a rule, does not interfere with life for many years, and in one case was discovered accidentally in a patient eighty-eight years old. In many cases the diagnosis is not made. When, however, there are symptoms of chronic interstitial nephritis with characteristic cardiovascular changes, and tumor masses can be felt in the region of each kidney, the diagnosis of bilateral cystic disease is justified. In regard to the treatment, it is, for the most part, non-operative. Nephrectomy can only come in question when it is certain that the disease is unilateral. Ureteral catheterization alone would not suffice to make the diagnosis, and an exploratory laparotomy should first be made to determine the existence of one normal kidney. So often, where a nephrectomy has been done, uremia and death quickly followed and the autopsy revealed the remaining kidney cystic. Therefore, although a few recoveries have been recorded from nephrectomy, routine treatment by operation should be limited to punctures and multiple incisions of the cysts from a lumbar incision, when by their size or by pressure the cystic kidneys are burdensome.

Movable Kidney.—In this condition experiences are multiplying in which because of rapid fat absorption there is a general loosening of the fibrous supports and the movable kidney is only part of a panoptosis. Rest in bed, postural treatment, and a diet intended to increase the fat frequently causes, if not an anatomic cure, at least an amelioration of all the symptoms. By many observations during operation I have been convinced that every loose kidney has potentially the elements of obstruction to the free outflow by reason of the rotation which almost always is associated with mobility. In this rotation the upper pole tends outwardly and the lower toward the middle line. The ureter naturally, therefore, might easily be pressed against from without by the lower pole. Very painful movable kidney, particularly when a small intermittent hydronephrosis exists, as shown by ureteral catheterization or by radiogram, should be made the subject of fixation. In

the purely neurotic cases the propriety of operative interference is still *sub judice*. Like every other surgeon, I have operated on a number of such cases and have encountered failures, but none have been made worse by the procedure. In the comparatively young with long lives of invalidism before them, there can be no harm done by the operation, which *per se*, is practically devoid of danger. It seems to be the consensus of opinion that when both kidneys are movable they should be operated on simultaneously.

Some very remarkable results have been achieved in England in cases of *lunacy associated with renal mobility*. For example, Suckling has quite recently reported 21 cases of insanity in which the fixation of the movable kidney was followed by the disappearance of the mental symptoms. Billington more recently reported 12 operations on people who were quite insane at the time of operation, and who would have been sent to an asylum immediately had not operation been advised: 6 of the 12 cases were well at last accounts; 2 had suffered from mania: 2 from melancholia with suicidal impulses; 1 from mania with homicidal impulses; and 1 from delusional insanity. In 5 of the remaining cases improvement was noted, although the time was too short for a cure to have been complete. One case died from operation. The conclusion seems warranted that where the kidneys are found movable in an insane person, nephropexy should be advised before the case is sent to an asylum.

In regard to the operation nothing new has been devised, unless it be the use of the quadratus lumborum muscle as a sling to be thrown around the lower pole of the kidney. To do this, the muscle is divided longitudinally and its lower attachment to the iliac crest severed. The lower edge of this part of the muscle is then reflected toward the abdomen and attached to the fascia of the anterior abdominal wall, making a muscular sling for the kidney. The innervation of the muscle remaining intact, its fibers do not degenerate. Sonnenschein reports 21 cases thus operated on with complete and permanent success. I still continue my original practice of suspending the upper pole from the last rib. The use of the nephrocolic ligament as a sling or hammock for the lower pole and fastening it into the wound high up is a decided improvement on the technic which I have for a long time used.

Eclampsia from Acute and Chronic Bright's Disease.—Since Harrison's idea, that the relief of tension by capsule splitting is indicated in certain forms of Bright's disease, and since Edebohls' first operation in 1898, a very large amount of material has been gathered and fairly logical conclusions may be arrived at. In the acuter cases a tense capsule is certainly the rule, although in the chronic cases it is not unusual to find that the capsule is rather too large than otherwise. As has already been stated, the hope that new avenues for circulation would be opened has no basis, nor that the new capsule which forms will be less elastic. Both clinically and experimentally it has been shown that the new capsule is very much thicker than the original one. There is, therefore, no justification for the hope that Bright's disease once established can be cured by operation. Although the immediate mortality

of capsule splitting is 30 per cent., and that within a short period 44 per cent., many of the immediate operative results have been remarkable. It is interesting to note that animal experimentation bears out the value of operative interference in acute renal conditions. Thus, Rovighi found with cantharides nephritis in rabbits that all recovered after operation, while 50 per cent. of the controls died; with diphtheria toxin nephritis 50 per cent. were saved by decapsulation, while 100 per cent. of the control animals died. The operation in these acute conditions doubtless relieves local tension and edema and overcomes the renal block. The acuter forms of Bright's disease following the acute exanthemata, puerperal eclampsia, and chronic Bright's disease with exacerbations are, therefore, the cases in which operation is not only justifiable, but in which a permanent relief may be expected. In the chronic parenchymatous nephritis the prospects of relief are very slender.

Before an operation is determined upon in any case, even of complete anuria with threatened or actually existing convulsions, as in puerperal eclampsia, all medical resources should be tried. Among these I desire to call particular attention to the recent remarkable work of Prof. Martin H. Fischer, according to whose view the kidney changes and the clinical results therefrom are due to acidity of the circulation in the kidney. "Experimentally it can be shown that under the influence of a trace of acid the kidney has a tendency to fall apart into its morphologic constituents. The epithelial cells stick together and loosen *en masse* as the cement substances that bind the kidney structures together dissolve. This marks the origin of the epithelial casts. By more prolonged action of the acid or with a rise in its concentration, the epithelial casts are converted into granular casts and later still into hyaline casts. These can be reconverted into granular casts by neutralizing the acid or by adding various salts to give concentration." The rational treatment is the administration of alkalis. Water is indicated in large quantities to wash the acids out of the kidney cells. The only danger of giving water resides in its power in washing out the salts in the body and making it possible for the kidney and other organs to swell (Edema). This loss of salts must be covered by giving the salts. These principles of treatment hold not only for the experimental nephritides induced in animals, but are directly applicable to renal cases. For this purpose sodium chlorid, 14 gm.; sodium carbonate (crystallized), 20 gm.; water, 1000 c.c. are utilized by rectal instillation or, preferably, by intravenous injection. The solution must be injected slowly, so as to allow ample time for mixing with the blood. The treatment has been used in over 40 cases of acute nephritis, puerperal eclampsia, and anuria from various causes with very remarkable results. There was only one death. Fischer thinks that these alkali-salt-water injections must prove of service in surgical operations on the kidney in which it is at times deemed necessary to occlude temporarily the blood-supply to the kidney. His experimental proof of this seems positive. According to his results this treatment will probably do away with the necessity of operative interference in the conditions under consideration.

Nephrotomy by Silver Wire.—Recently Cullen and Derge have devised a very ingenious method of bluntly dividing the kidney parenchyma by means of a No. 3 or 4 silver wire. Their researches in dogs along these lines have shown that there is in this method a minimal amount of hemorrhage; that after this method there are no spurting vessels seen in the kidney wound such as are always seen after division of the kidney with a knife. In a tabulated series of experiments the amount of hemorrhage after this wire nephrotomy was less than one-half of that after the ordinary nephrotomy made by a knife. The authors of this idea examined a large number of kidneys at varying times after operation, and found that there was far less destruction of the kidney substance by infarcts. There was always a small infarct present which was, however, in each case less than in the control nephrotomy made by a knife. This procedure is to be particularly recommended in all cases where the pelvis of the kidney must be explored. I have used it in several cases of nephrolithotomy with gratifying results. In detail the procedure is as follows:

After delivering the kidney the topography of the blood-supply should be accurately determined. If the kidney is round in front with pulsating arteries at the anterior hilum and the posterior surface flat with a deep notch, then anterior circulation predominates. This is a condition found in four-fifths of all cases. In these cases the incision should lie in the posterior part of the kidney. In a minority of cases the circulation is just reversed. This will be revealed by a flattening of the anterior and a rounding of the posterior kidney surfaces. The deep notch will be found anteriorly and the pulsating vessels posteriorly. In these cases the incision should lie in the anterior part of the kidney. In some few cases where the notches seem thick and pulsating vessels may be flat, both anteriorly and posteriorly, then it is probable that the division is in the middle line. If this is true, the incision should lie in the middle line.

Cullen in his article brings out another point, that is, the determination whether the pelvis is intra- or extrarenal. Its importance lies in the fact that in an intrarenal pelvis a single incision is ample, while in the extrarenal pelvis the upper and lower poles of the pelvis are divided by a thick vascular bridge of renal tissue, the division of which may be hazardous. An intrarenal pelvis may be recognized by a narrow, small hilum, while an extrarenal pelvis is recognized by its long hilum with widely separated renal poles.

The additional instruments necessary for the wire nephrotomy are assorted blunt, full-curved, and straight liver needles and a No. 3 silver wire. The technic differs slightly in the different regions of the kidney. If a small nephrotomy is to be made in the lower pole of the kidney, a full-curved needle armed with the silver wire is introduced into the upper posterior margin of the pelvis and brought out at the radial point of the convex border of the kidney. The capsule is then split with a knife along the line through which the wire will cut. By a gentle see-saw motion with fair traction the kidney is gradually cut. As soon as the

FIG. 312.—SECTION OF INFARCTS IN DOG'S KIDNEYS, MAGNIFIED 6.5 TIMES. (Ernest K. Cullen in "Surg., Gyn., and Obst.")

Showing the comparative results obtained in the wire and knife incisions, the knife having been passed from cortex to pelvis. The arteries were injected in both cases in order to demonstrate the fine preservation of the blood-vessels in the wire wound. Note the difference in shape and width of the cortical infarct in the two specimens.

resisting pelvis is cut through, the traction must be even more gentle to avoid cutting the smaller renal vessels (Fig. 313). When the upper pole of the kidney is to be opened, the incision corresponding to this can-

not be used, as this incision would pass through the large posterior branch of the renal artery. If the upper pole of the kidney or the whole pelvis is to be explored, the operation may be begun as in the previous manuver. Then the large needle is reintroduced at the upper angle of the first incision, passed through the renal pelvis, and brought out at the corresponding point near the upper pole. After splitting the capsule with a knife the kidney is then opened as in the previous step (Fig. 314). If a certain small portion of the kidney is to be opened, the incision may be made in the same manner in any one of the less vascular regions.

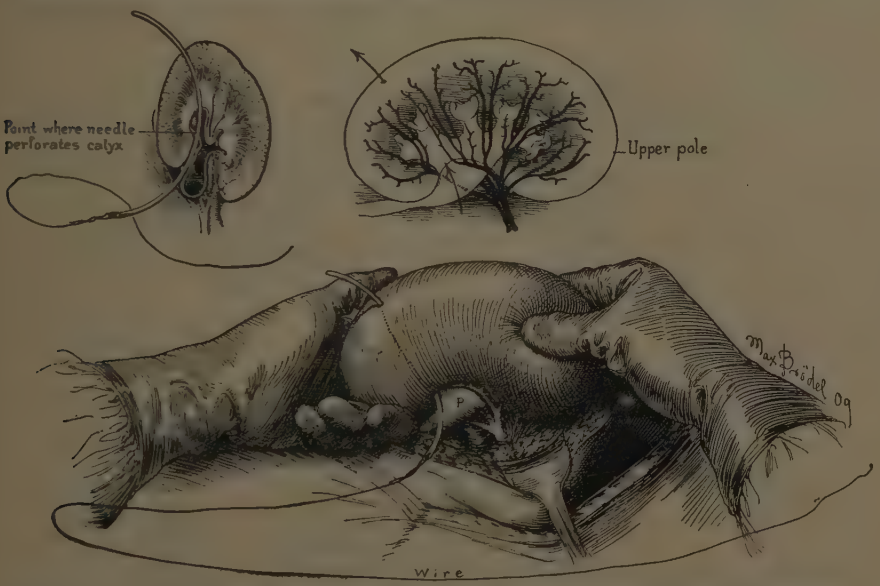

FIG. 313.—THE PLACING OF THE SILVER WIRE WITH THE CURVED NEEDLE IN AN OBLIQUE DIRECTION THROUGH THE POSTERIOR PARENCHYMA. (Ernest K. Cullen in "Surg., Gyn., and Obst.")

The needle enters the renal sinus between parenchyma and pelvis at the lower end of the hilum, glides along the lower posterior calyx until the point of the needle encounters the corresponding papilla, at which point the pelvis is perforated. (See upper left diagram.) The needle is now gently pushed through the renal parenchyma until it is seen to emerge at the lateral border. The upper right diagram illustrates the direction of the blood-vessels in relation to this incision. It is clearly seen that this proposed oblique incision runs through an avascular zone and opens in the lower half of the renal pelvis.

Lilienthal has devised a new method of **total excision of the ureter** which is particularly applicable to cases of tuberculosis of the kidney. The ureter and vessels are tied separately according to Lilienthal's technic. The stump of the ureter is cauterized with pure carbolid acid and turned into the wound, and a long flexible urethral bougie is passed down toward the bladder. A ligature is tied tightly around the ureter and instrument, so as to hold the bougie in place. The lumbar wound is closed with drainage and the patient turned on his back. An oblique incision from $1\frac{1}{2}$ to 3 inches long is made about 1 inch to the median side of the anterior superior iliac spine. This is carried through the abdominal muscles to the peritoneum. which is peeled back, and the ureter, with its bougie in place, easily recognized. The ureter is now lifted by

the finger into the wound, while the bougie is removed by an assistant through the lumbar wound. By pulling through the lower wound the ureter is dislocated downward and may be felt by the finger almost to the bladder, where it is tied. A soft drain is now introduced for a few days to prevent possible infection. A hard-rubber tube must never be used on account of the danger of injuring the iliac vessels.

A simpler method than this can be instituted by the use of a blunt uterine curet. After the division of the ureter at its pelvic junction, the curet is slipped over the ureter and gradually pushed downward toward the bladder. The ureter can be quite as easily separated in this manner

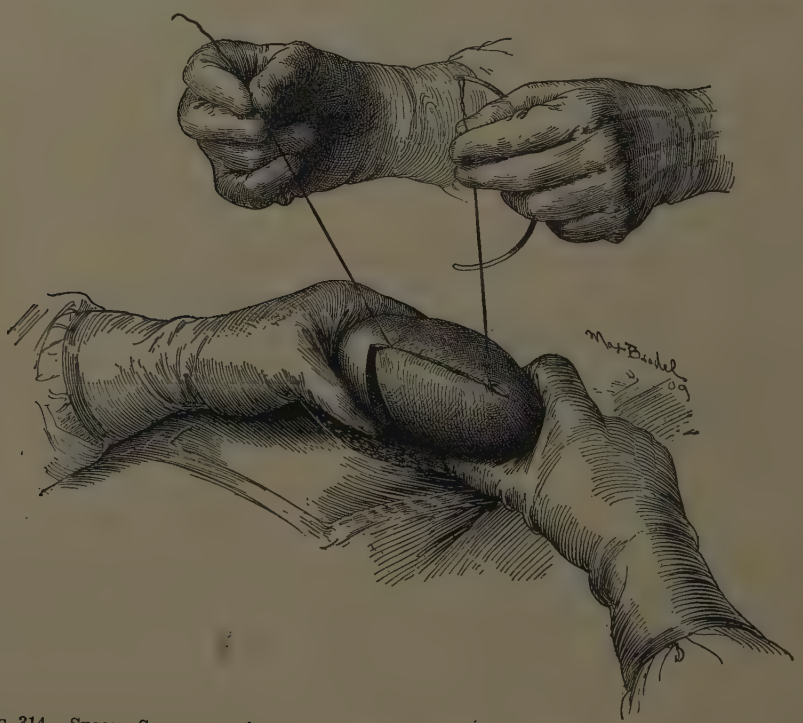

FIG. 314.—SECOND STEP IN THE L-SHAPED INCISION. (Ernest K. Cullen, in "Surg., Gyn., and Obst.")

from its bed as is a varicose vein in the operation usually performed for this condition. When the lower end of the curet is advanced as far as possible, it is brought to the skin, which is buttonholed over it. The enucleated part of the ureter is delivered through this opening. In its technic this modification closely resembles the operation for removing the long saphenous vein. Whereas, either of these measures of ureterectomy is easily practised when the ureter is nearly normal or not much thickened, or irregularly dilated, it is not feasible in the cases in which the opposite conditions obtain. The ureter, as a result of obstruction by a large stone low down, from cicatrices or tuberculous ulceration, at times becomes as large as the thumb and may resemble a very much thickened

small intestine. Under these circumstances, if the ureter is to be removed at the first operation, nothing short of complete exposure will answer. It is questionable whether in such cases the operation should be performed, since ureterectomy is not always an essential to the complete cure. If in these cases where a greatly diseased ureter is left and causes a discharging fistula, it can always be removed by a subsequent operation after the patient has recovered fair health after the nephrectomy.

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CHAPTER CXXXIV.

STONE IN THE BLADDER.[1]

By Arthur Tracy Cabot, M. D.,

Boston.

The experience of modern operators in the comparative mortality of the various methods of stone removal and in the probability of recurrence after each, bears out the statements in the original article.

Fig. 315.—Showing the Patient in Position for a Skiagraph of the Bladder. (Walter J. Dodd.)

Litholapaxy remains the operation of choice, and cutting operations should be resorted to only in exceptional cases, as are there fully set forth.

Considerable ingenuity has been exercised in combining a cystoscopic and a crushing apparatus.

Earlier instruments of this sort (Nitze, Caspar, etc.) are comparatively feeble for crushing.

[1] Supplementary to Chapter LVIII., Vol. IV., p. 335.

George Walker was the first to adapt a cystoscope to a powerful lithotrite. His instrument was tested to 175 pounds' pressure.

Young has further added to this instrument an evacuating bulb of his own.

Such instruments are not practicable in disposing of stones of any size. The bladder fluid would be rendered opaque by dust after each crushing, and the frequent washing to clear this out would greatly and uselessly protract the operation. They may have a distinct field in the seizing and crushing of a last elusive fragment. The ordinary lithotrite, aided by Chismore's aspirating lithotrite, usually performs this service so satisfactorily, however, that the need of these cystoscopic in-instruments must be exceedingly rare.

FIG. 316.—SHOWING THE SKIAGRAPH OF THE PELVIS TAKEN IN THE POSITION SHOWN IN FIG. 315. (Walter J. Dodd.)

The *x*-Ray as a Means of Diagnosis in Stone in the Bladder and Accompanying Conditions.—The constant improvement of the apparatus and technic used in *x*-ray examinations, and our added experience in interpreting the pictures obtained has greatly added to the accuracy of this method of investigation.

Fig. 315 shows how the patient should be placed in relation to the tube and plate in order to bring the bladder into view with the least possible overlapping of the bony framework, and Fig. 316 gives the pelvic picture obtained by this position.

It is also possible to take a good picture of the pelvic contents by laying the patient on his face upon the plate and then fixing the *x*-ray tube over the posterior outlet of the pelvis (Fig. 317).

FIG. 317.—SHOWING PATIENT IN POSITION FOR SKIAGRAPH OF BLADDER TAKEN FROM BEHIND. (Walter J. Dodd.)

FIG. 318.—SHOWING A STONE IN THE RIGHT URETER A SHORT DISTANCE FROM THE BLADDER, AND TWO STONES IN THE LEFT URETER, THE ONE NEAREST THE MIDDLE LINE BEING IN THE VESICAL ORIFICE OF THE URETER. (Walter J. Dodd.)

Hugh Cabot verified this by cystoscopic examination, during which he displaced the projecting stone and saw the other follow it into the bladder. The picture is reversed in printing.

By taking several pictures at different angles, with the bladder in varying conditions of distention, and by changing the position of the patient from side to side between the different exposures, some light may be thrown on the question whether a stone lies in a diverticulum or is otherwise attached to the bladder wall, or whether it is free in the bladder cavity (Figs. 318, 319).

FIG. 319.—A LATER PICTURE OF THE BLADDER SEEN IN FIG. 318 (Walter J. Dodd.)
The two stones from the left ureter are now seen near the neck of the bladder. Picture reversed in printing.

When there is reason to suspect that the stone is not free and movable, a cystoscopic inspection will usually make the condition clear.

In seeking to know before operation all that can be learned as to diverticula that may be present, a skiagraph may be taken of the bladder filled with protargol. This is opaque to the *x*-ray and may demonstrate the size and position of saccules.

CHAPTER CXXXV.

SURGERY OF THE PROSTATE.[1]

By Hugh H. Young, M. D.,

Baltimore.

Surgery of the prostate has not changed materially during the past four years. To the subject of **cyst of the prostate** I am able to add a recent case of considerable interest.

A young man, aged thirty-three, appeared, complaining of difficulty of urination of several years' duration. He had not had gonorrhea and was otherwise healthy.

Examination showed that the prostate was not enlarged; there was no evidence of chronic prostatitis; the urine was clear.

The cystoscope entered easily and showed a cyst about 2 cm: in diameter projecting through the prostatic orifice into the bladder, and attached by a broad pedicle along the left anterolateral margin of the urethra. The translucency of the cyst was quite evident when viewed with the cystoscope, particularly as it was being drawn outward, the light being on one side of the cyst and the lens on the other. The rest of the prostatic margin was normal in appearance and the bladder was entirely negative. This cyst was successfully removed by means of my cystoscopic rongeur. Examination of the tissue showed that it was lined with epithelium, both inside and out. It was evidently filled with clear fluid. There was only a moderate amount of hemorrhage. It was not necessary to use a catheter, the patient being able to void his urine immediately afterward, and expressing himself at once as having much greater facility of urination than he had had for several years. He remained in the hospital a few days, during which time there was very slight hemorrhage, and he did not require catheterization. No infection occurred, and the patient has since been entirely well.

Diseases of the Colliculus and its Appendages.—The literature of the colliculus, or verumontanum, is recent, and the clinical importance of this structure and its appendages has only lately been recognized, notably in the articles by Swinburne, Wossidlo, Goldschmidt, Geraghty, and Buerger.

The colliculus has been shown to be the seat of frequent pathologic changes. The contributing causes are gonorrhea in most of the cases; in others, however, there is no venereal history, but one is usually able to obtain a record of masturbation frequent and long continued, or of prolonged sexual excitement without intercourse.

[1] Supplementary to Chapter LIX., Vol. IV., p. 372.

Gonorrheal changes appear as a chronic inflammatory condition, the colliculus being enlarged, the surface rough, granular, and markedly congested, and the orifices of the utricle and ejaculatory ducts difficult to make out. Sometimes they are definitely contracted. Where the orifice of the utricle is narrowed, one often finds the utricle distended with fluid and at times considerably dilated. I have seen several cases where the utricle was 3 cm. long and would contain more than 3 c.c. of fluid. By means of his utricle syringe Geraghty has obtained purulent fluid, cultures from which showed a chronic infection of the utricular pouch, the cure of which put an end to a urinary infection which had previously resisted various forms of treatment.

In other cases the lips of the utricle appear swollen, edematous, red, and pouting, with or without constriction of the lumen. Study of the condition of the ejaculatory ducts is less satisfactory. In some cases they enter into the lateral walls of the utricle and cannot be seen; in others, through the opening on the surface of the colliculus, on each side of the utricular orifice, they are difficult to see or to explore with the fine blunt-pointed needle of the utricular syringe. It is also somewhat dangerous to inject fluid into an ejaculatory duct, as epididymitis may result therefrom. Since Belfield has called attention to the importance of chronic infections of the ampulla of the vas deferens, the indications for ejaculatory duct investigation and therapy have become more justified, and with recent improvements in urethroscopy we may confidently expect advances in this line.

Prolonged sexual excitement without intercourse, coitus interruptus, the practice of withdrawing before ejaculation, masturbation, and other forms of unnatural sexuality lead to conditions of the colliculus and its appendages similar to, and often more severe than, those of gonorrhea. The colliculus is generally much enlarged, very red, congested, and bleeds easily and profusely. In some cases the surface is smooth, in others granular, at times nodular and almost villous. The changes in the utricle and ejaculatory ducts are similar to those described before. In these non-gonorrheal cases the prostate is usually swollen, often considerably enlarged and soft, as if the acini were distended. Massage expresses an abundant secretion containing pus cells mixed with a varying amount of normal elements. The seminal vesicles are also usually found distended, thickened, tender, and often adherent and filled with pus, as shown by examination of the expressed contents.

The symptoms produced by pathologic conditions of the colliculus are so wrapped up with those of chronic prostatitis and vesiculitis that it is often impossible to separate them.

That various sexual disorders are quite specifically attributable to the verumontanum seems definitely proved, viz.: precocious imperfect or painful ejaculations, diminution of sexual desire, and imperfect erections, and pain or chronic irritation in the deep urethra and perineum. All of these symptoms are usually eradicated or benefited by local treatment of the verumontanum. Certain referred pains seem to be due to the same cause, viz.: suprapubic irritation or dull pain, occasionally

leading to frequent and painful urination; dull pain in the lumbar region (often a tender point between the vertebral spines) and along the course of the external cutaneous nerves where they cross the crest of the ileum (there being often a definite tenderness at this point).

Many or all of the above-mentioned symptoms may be induced or increased by the incomplete ejaculations which often accompany imperfect erections or precocious ejaculations. Geraghty has also been able to produce these pains by distention of the utricle with water, and local urethroscopic treatment to the utricle and to the exterior of the colliculus has caused their disappearance.

I have gone thus into detail because these conditions have received little general recognition, and because their widespread and distressing symptoms make their importance great.

Diagnosis.—Colliculitis may be suspected when certain symptoms, singly or in groups, are present, viz.: irritation (burning or pain) in the deep urethra, perineum, or rectum; sexual disturbance: precocious ejaculations, diminished desire, and impaired erections, etc.; nocturnal emissions and painful erections; referred pains, lumbar and suprapubic; frequent urination due to irritation and without obstruction.

Examination by rectum will usually reveal an exquisitely tender spot in the middle of the prostatic urethra (and also usually distention of the seminal vesicles and prostate, the expressed secretion containing pus cells). The passage of a catheter or sound will generally elicit a cry of pain when the point of the instrument reaches the site of the verumontanum. The urethroscope is, of course, the most certain diagnostic method, as it is possible to inspect the colliculus to sound the utricle and test its depth and capacity (after obtaining its contents for microscopic study in certain cases).

For this purpose Swinburne's posterior urethroscope has been used for many years with great success. A straight tubular urethroscope with external illumination, as in the models of Otis, Squier, and Young, may also be used. Recently the cysto-urethroscopes of Goldschmidt, Buerger, and Pilcher have had considerable vogue, as they give a more magnified view of the deep urethra. By any of these instruments it is possible to make accurate diagnosis of the numerous pathologic states of the colliculus.

Treatment.—Only local measures give results in this conditions. The time-honored instillation of nitrate of silver into the posterior urethra (a few drops of 5 per cent. solution by means of a Keyes-Ultzmann syringe) is a simple method of great value. It should be used occasionally—about once a week. Massage of the prostate and seminal vesicles is generally necessary owing to the presence of chronic inflammation, and should usually be followed by vesical lavage (by hydraulic pressure without a catheter) with a solution of nitrate of silver (1 : 10,000 to 1: 5000).

Urethroscopic treatment is the most accurate and successful. For this purpose I prefer a tubular instrument, with the light outside, through which operative attack can be made upon the colliculus, utricle,

etc., with rongeur, scissors, curet, scalpel, instillating needle, dilators, probes, etc., and applications of a stick of nitrate of silver with a porte-d'argent can be made direct.

When there is much hypertrophy of the colliculus I usually attack it vigorously with the small rongeur, thus excising many small bits, and follow this by a vigorous curetage and then application of the stick of silver. At subsequent treatments (with intervals of ten days or more) it is usually sufficient to use less vigorous measures—the local application of silver and intra-utricular instillations of 1 to 2 per cent. silver as suggested by Geraghty. Later, applications of 20 or 10 per cent. silver, as used by Swinburne, are sufficient.

Under such treatment the appearance of the verumontanum rapidly returns to normal, and the painful local and referred symptoms and neuroses often diminish as if by magic. Most of the sexual disorders in the male have their seat in a pathologic verumontanum, are usually curable by intelligent treatment, and, therefore, deserve more consideration than they have usually had from the medical profession, which is usually content to brand the condition "sexual neurasthenia," and relegate the unfortunate to nerve tonics.

Chronic Prostatitis.—The subject of chronic prostatitis has received increasingly greater attention during the past four years. There has been a more general recognition of its great prevalence by the medical profession, and a better understanding has been reached in regard to the multiple reflex symptoms which this disease is capable of producing. The fact that many pains in the region of the kidneys, many supposed lumbagos, sciaticas, and neuralgias of the groins, hips, thighs, back, and lower extremities are due to inflammatory infiltration in and around the prostate and seminal vesicles, is now becoming better known, and as a result many cases which were treated previously in the hospitals for neurasthenia are now being cured by treatment of the prostate and seminal vesicles. The great value of massage of the prostate and seminal vesicles, and of local treatment by means of irrigations of nitrate of silver and urethroscopic applications to the posterior urethra and verumontanum, have become more and more evident, and the medical profession has come to a realization that physical examination without careful study of the rectum and prostate by means of digital exploration is not complete. The great value of microscopic examination of the contents of the prostate, which can be so easily forced to the meatus by simple pressure through the rectum, has not yet been fully realized, and we cannot lay too much stress here upon the great importance of such examinations before pronouncing a case of chronic gonorrhea cured or before giving permission to marry in cases in which gonorrhea has been present at some previous date.

Recently an addition of very great value has been given us in the complement fixation test for diagnosing latent gonococcic infections which has been introduced by Hans J. Schwartz. By using fourteen different strains of gonococci, Schwartz has given us a diagnostic method of very great value, and it should now be possible to tell accurately when

a patient can safely marry without danger of infecting his wife. Owing to the difficulty of obtaining cultural or microscopic evidence of gonococci in the prostatic secretion in the past, it has been necessary to say that all cases in which there was a considerable amount of pus present in the secretion of the prostate, the patient should be prohibited from marrying. It was evident that in many such cases the process was not a gonorrheal one, but owing to the inability of finding the gonococci in cases in which it was quite certain that they were present, it was necessary to adopt a stringent rule as above described. With the advent of the new Schwartz test the subject is greatly simplified, and it should now be possible to determine quickly what cases should be allowed to marry, and what should not, a thing of very great importance.

During the past four years the frequency with which chronic prostatitis is associated with obstruction to urination has become more and more evident, and although in my previous chapter I called attention to the fact that quite often it was necessary to perform operations to remove the obstruction in cases of chronic prostatitis, the subject has become so much more important that it will be dealt with at length here.

Contracture of the Prostatic Orifice.—Since the time of Home the occurrence of obstruction to the outflow of urine at the prostatic orifice of a non-hypertrophic character has been recognized. Attention was particularly directed to this condition by Mercier, first in 1836 and afterward in numerous publications, under the name of "valvules du col de la vessie." Keyes and Chetwood, in America, have kept alive the interest in this condition, to which they gave the name "contracture of the neck of the bladder."

Mercier recognized two forms, the muscular and the prostatic. "Often," he remarks, "one sees the posterior border of the neck of the bladder forming such a forward prominence that it rises 8 or 10 mm. above the level of the posterior wall of the urethra, and as it projects almost at an acute angle it results that the canal, when it has been opened by its superior wall, appears *coudé* in shape. The urethro-vesical orifice is large enough to allow the passage of a sound of large caliber, but it has lost its elasticity, and the valvule offers, at times, such resistance that it is difficult to separate the lateral lobes of the prostate when the canal is opened in front. If one makes several incisions through this valvule one finds it composed of grayish-white tissue, and it is only at a certain distance that one meets prostatic tissue. This tissue is a part of the transverse muscular layer. Almost always the mucous membrane offers in the vicinity traces of chronic inflammation. Generally the prostate is not enlarged, but it is hard, compact, and difficult to cut. The verumontanum in most of the cases is enlarged." Such is Mercier's description of the muscular valvules (which I have translated very freely). In regard to the second form he says: "It is more prominent, has generally its free border rounded, and is thicker than the muscular type. The urethra at this point forms an inverted crescent, but easily admitting the finger. After incision one meets immediately prostatic tissue; it is then formed of the supramon-

tanal portion of the prostate. Often this is accompanied by some hypertrophy of the lateral lobes." I have quoted thus at length from Mercier because in succeeding years the existence of his " valvules " was largely lost sight of on account of a concentration of interest in prostatic hypertrophy.

Keyes' term " contracture of the neck of the bladder " and his publications laid great stress upon the strictured condition of the internal orifice, a condition which is very frequently present, and is characterized by a fibroid ring surrounding the urethrovesical orifice.

My attention was first called to these cases when, during the course of prostatectomy, the lateral lobes were found to be non-hypertrophied, but when an attempt was made to insert the finger into the bladder a fibrous ring was encountered which required instrumental dilatation with considerable force. An examination would then show that the median portion of the prostate was elevated in the shape of a small transverse bar of very fibrous consistence.

A study of about 100 cases shows that they may be divided into three types: viz., the muscular, the fibrous, and the glandular.

The muscular type is rare and is often congenital in character. The patient gives a history of urinary obstruction and frequency since childhood—he has " never been able to urinate quickly and forcibly like other boys." Some of these cases varied little with the progress of years; others developed numerous complications, *e. g.*, vesical diverticula, ascending infections, pyonephrosis, calculus, etc.

The tissues removed in these cases showed that the bar resulted from hypertrophy of the muscle beneath the urethrovesical orifice. One of these was associated with a general hypertrophy of the musculature of the trigone, and the obstruction was not removed until the trigone had been divided longitudinally. Inflammation, though present, seemed to play no part in the production of the obstruction, which may be termed a congenital muscular malformation or hypertrophy beneath the urethrovesical orifice.

The fibrous type is the more common, and occurs in more or less pronounced degree in about 15 per cent. of the cases of chronic prostatitis. The median portion of the prostate in these cases is elevated above the level of the trigone in the shape of a bar, and the urethrovesical orifice is tight and difficult to dilate, the sensation, to the finger, of a fibrous ring being very marked. The microscope shows in these cases an inflammatory infiltration of the sphincteric muscle, and a fibrous hyperplasia which forms a definite ring around the urethra, enough to justify describing the condition as stricture of the prostatic urethra at this point. The rest of the prostate shows the varied lesions of chronic prostatitis, including changes within the acini of a hyperplastic character.

The glandular type consists of a hyperplasia of the acini in the median portion of the prostate. This may involve the prespermatic group or the subcervical group, or both, as in one of my cases. The pathologic condition is usually inflammatory and corresponds to the

changes described under the chapter on Chronic Prostatitis, of which it is usually a part. Outside of the acini one sees the usual inflammatory infiltration, and within the reduplication of epithelium and epithelial stalks which is also seen in adenomatous hypertrophy of the prostate.

In some cases, particularly in elderly men, the condition is, indeed, a small but true hypertrophy in the shape of a bar or sessile lobe, with little or no hypertrophy of the rest of the prostate. In this type there may be little or no fibrous infiltration, no hard ring around the urethra, which may be readily dilatable. But not infrequently the inflammatory and the glandular type go together, so that we find both the fibrous ring and the hypertrophic glandular median bar.

The **symptoms** produced by all three types of lesions may be very similar. Of first importance are the obstructive symptoms, which manifest themselves first as a hesitancy at the beginning of urination, associated later with abnormal frequency of urination and diminution in the stream of urine. In some cases the amount of residual urine is small, 20 to 50 c.c., but the bladder becomes hypertrophied and contracted, so that the frequency is largely due to lack of capacity, associated in some cases with irritability of the bladder. In other cases the amount of residual urine may increase and become very large, or even complete retention may supervene. In such cases the symptomatology may be identical with that of prostatic hypertrophy. I have seen several patients under forty years and two under thirty years of age leading catheter lives on account of complete retention of urine from this cause.

Another important group of symptoms—present in about half of the cases—are painful in character. The simplest are characterized by irritation or burning in the deep urethra, perineum, or rectum. Often these amount to real pain which may radiate to the end of the penis, and be referred also to the suprapubic region. Occasionally the pain is of very distressing character, so that the patient becomes almost frantic. These symptoms are generally cured or greatly improved by excision of the obstructive bar, so that it would seem probable that they are due to irritability at that point. In other cases the irritation seems to be due to lesions in and around the verumontanum and its appendages, as they can be cured only by postoperative treatment to these structures of the deep urethra. In the same category are changes in sexual vigor, chronic prostatitis, and seminal vesiculitis, all of which may be present and require treatment.

Treatment.—Local treatment—prostatic massage, dilatation with the Kollmann dilator, irrigations of 1: 10,000 to 1: 5000 nitrate of silver, instillations of a few drops of 5 per cent. nitrate of silver into the deep urethra, or urethroscopic treatment—may result in considerable improvement in the symptoms. This is particularly true where they are due to chronic inflammatory lesions of the prostate, verumontanum, seminal vesicles, and bladder, and in such cases local treatment as indicated above should generally be given before and after radical operation to remove the obstruction is undertaken.

The operative measures are of two kinds, division and excision. Division may be done through perineal or suprapubic incisions. The perineal is the older and more popular, and consists generally in a median prostatotomy—very similar to the old median lithotomy operation. The objection to this procedure is the occasional production of incontinence, due to division of both sphincters.

Division of the bar may also be done with the Bottini electrocautery instrument, as described elsewhere, or by the method of Chetwood through a small perineal incision. The latter method has been used by Chetwood for many years upon these cases of " contracture of the neck of the bladder," as he designates them, and with splendid success. In fact the use of the Bottini operation or its modifications seems now to be largely restricted to such cases.

Excision may also be perineal, suprapubic, or urethral. The perineal excision takes place in the course of a perineal prostatectomy—the median portion of the prostate being excised after the lateral lobes have been removed. I have carried out this procedure in over 50 cases. It is sometimes the method of choice, especially where the lateral lobes are markedly abnormal, enlarged, and chronically inflamed. In some cases it may be wise during the perineal prostatectomy to attack the posterior urethra and verumontanum if pathologic conditions resulting in pain or severe nervous symptoms are present.

By means of conservative perineal prostatectomy no difficulty is experienced in removing very fibrous lateral and median lobes, and in thoroughly dilating the sclerotic internal sphincter. But such is not true with the suprapubic methods of prostatectomy, for, as Freyer remarks, this method is not suitable for small fibrous prostates, and if attempted may result in a removal of the prostate *in toto*—capsule, urethra, sphincter, and all—and in a few cases has resulted in severe stricture or even complete obliteration of the deep urethra.

Excision of the median portion of the prostate may also be done effectively through the urethra by means of a " urethroscopic median bar excisor " or " punch " devised by myself three years ago. It may be well to mention here the reasons which led to its development.

On January 27, 1909, I saw a patient in whom rectal examination showed a prostate no larger than normal. The catheter withdrew 500 c.c. residual urine, the cystoscope showed a small but definite transverse median bar, but no intravesical enlargement of the lateral lobes. With finger in rectum and cystoscope in urethra there was a definite increase in the median portion of the prostate.

The patient objected to prostatectomy, and I finally consented to remove the median portion of the prostate through a suprapubic operation. This was carried out two days later. The prostatic orifice was found to be surrounded by an inelastic ring, difficult to dilate, and in the median portion there was a small bar only slightly elevated above the trigone. With forceps and scissors this was excised, the vesical orifice dilated, and apparently all obstruction removed. The patient convalesced slowly, remained in the hospital for eight weeks before the supra-

pubic fistula healed, and a month later showed evidence of recurrence of obstruction. In the course of three months the suprapubic fistula reopened, obstruction at the prostatic orifice being almost complete, and in a short time the patient died of uremia.

A study of this case brought forcibly to my attention the fact that it should be possible to treat such cases by means of excision of the median portion of the prostate through the urethra, and I therefore set about to construct an instrument by means of which this could be done. Fig. 320 shows the final outcome of my experimentation. It consists of an outer tube about 18 cm. long with a coudé curve at its inner end, and a urethroscopic disc at the other, containing a post upon which an external urethroscopic light can be attached. Near the inner end on the under surface a large deep fenestra is provided, as shown in the illustration. Within the instrument is a second tube which has a sharp cutting inner end made of steel, which when pushed home can excise anything appearing inside of the outer tube. The object of this instrument was to

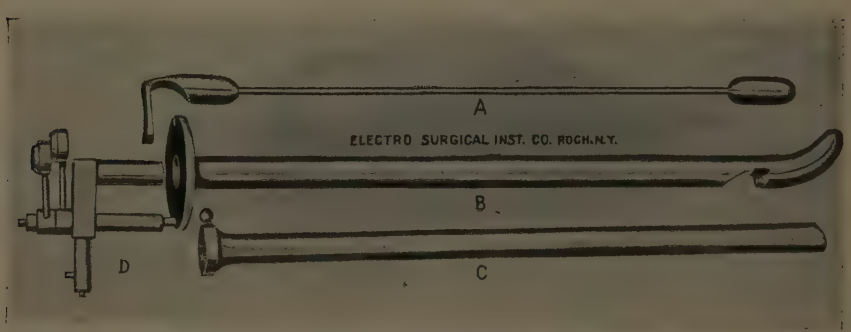

FIG. 320.—YOUNG'S URETHROSCOPIC MEDIAN BAR-EXCISOR OR PUNCH.
A, Obturator; B, outer tube with fenestra; C, inner tube with cutting end of steel; D, light carrier rotating on a peg and removable.

be able to engage the median bar in the fenestra by pushing the instrument through the urethra into the bladder, and then to excise it by means of the inner cutting tube while observing the operation through the inner tube illumined with the external urethroscopic lamp.

The first operation was performed with this instrument on February 1, 1909, in my office, under local cocain anesthesia, and a piece of tissue about 7 mm. in diameter and 1.3 cm. long was excised without pain, with little subsequent hemorrhage, and splendid functional result in a case of small median bar obstruction of long duration. Since then I have operated upon numerous cases, and am now able to report 69 cases of obstruction to urination of the median bar type, and others with peculiar small enlargements of the lateral or anterior portions of the prostate, which have been operated upon with this instrument.

Before detailing these cases it may be well to speak more definitely in regard to the technic of the operation as now performed:

The instrument is usually inserted with the cutting obturator pushed home until the end of the instrument is felt to enter the vesical orifice.

The inner tube is then withdrawn about 2 cm., the electric light attached externally, and an inspection made. As a rule, the verumontanum will be seen bulging into the fenestra. The instrument is then pushed slowly inward, the verumontanum is seen to disappear, and, finally, the median portion of the prostate gradually enters and completely fills the fenestra. If the instrument is pushed a little farther inward, urine escapes, showing that it is in the bladder. By drawing it outward the flow of urine ceases, showing that the inner edge of the fenestra is caught against the median bar, a good view of which is easily obtained after aspirating the fluid from the interior and drying with swabs. The inner cutting tube is then rapidly pushed home, and excises in one piece the tissues caught in the fenestra. With alligator or ronguer forceps, inserted into the instrument, this piece of tissue is removed, and will generally be found to be about 7 to 8 mm. in diameter and 1.2 to 1.5 cm. long, one-third of its circumference being covered with mucous membrane, partly vesical and partly urethral. Experience has shown that one cut is usually not sufficient, and that it is wise next to turn the instrument first to the right and then to the left in order to remove more of the median bar on each side. The lateral cuts never excise as much as the posterior median, generally about one-third as much. The cutting inner tube is then

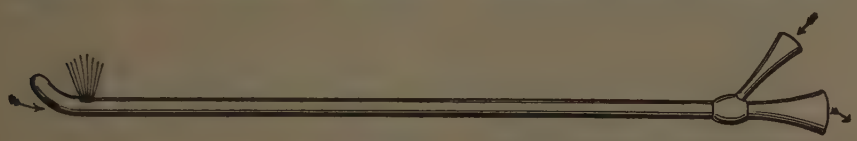

FIG. 321.—YOUNG'S TWO-WAY GUM CATHETER FOR CONTINUOUS IRRIGATION OF BLADDER, MADE IN SIZES 27 TO 31 F.

removed; the bladder is washed out through the outer tube, and when apparently clear of clots the obturator is introduced and the instrument withdrawn. Immediately afterward a two-way urethral rubber or gum catheter (Fig. 321) is inserted into the bladder (by means of a stilet if a gum catheter is used), and continuous irrigation at once begun. If clots are present these are evacuated by means of a large hand syringe, but generally this is not necessary. After the catheters have been fastened in place by means of adhesive strips around the penis, the patient is at once returned to the ward, where continuous irrigation is at once resumed. A large porcelain tank containing about 10 liters of sterile water at a temperature of 120° F., which is allowed to flow through a small tube into the bladder and out the large tube with sufficient rapidity to remove the blood and prevent clotting, is employed. This irrigation is kept up for twenty-four to forty-eight hours. Sometimes the tubes become plugged, and the large hand syringe has to be used to evacuate the clots. As a rule, the two-way catheter can be removed in from twenty-four to forty-eight hours. Only rarely is further catheterization necessary. By using the retained two-way catheter with continuous irrigation hemorrhage is easily taken care of, and the convalescence made extremely simple. Several of these patients have not even gone to the hospital, and many have left in two or

three days. As a rule, the patient is able to void his urine with much greater freedom at once, and the convalescence is extremely rapid and satisfactory, no treatment other than urotropin and water in abundance being required. The use of sounds and dilators has been found unnecessary. The median bar is so completely removed that no recontraction occurs, and unless some obstructing portion of the prostate remains after operation the cure is complete.

Study of Cases Suitable for the Punch Operation.—I have now (February 27, 1912) carried out this punch operation on 92 cases without a death; 4 of these cases were associated with pedunculated median lobes which were removed with the cystoscopic rongeur before the bar was removed with the punch, and 19 were cases on whom suprapubic or perineal prostatectomy had been performed here or elsewhere with imperfect results.

Sixty-nine cases were subjected to the punch operation as a primary procedure. In 2 cases the median enlargement was found to be too large to be removed by the punch, and perineal prostatectomy was performed later, revealing unexpectedly great hypertrophy of the lateral as well as the median portions of the prostate. Both were fat men, and the size of the prostate had not been appreciated. The punch operation should not have been attempted in these 2 cases.

In the other 67 cases the ages were as follows:

Between 20 and 29	3 cases.
Between 30 and 39	5 "
Between 40 and 49	15 "
Between 50 and 59	19 "
Between 60 and 69	16 "
Between 70 and 79	8 "
Over 80 years of age	1 case.

In 8 of these cases vesical calculi which were present were removed by litholapaxy before the punch operation was carried out. When ether was employed the punch operation was done immediately after the litholapaxy, in all of which my evacuating cystoscopic lithotrite was used (Figs. 322–324). Several of the litholapaxies were done under cocain, the punch operation being done at the same séance or a day or two later. All of these cases have been highly satisfactory, and demonstrate the great value of the punch operation after litholapaxy when prostatic obstruction of the median-bar type coexists. The frequent recurrence of calculi after simple litholapaxy shows the need in many cases, even in young men, of operative attack upon the prostate as well, and has been one of the strongest arguments for prostatectomy.

In 4 cases the operative result obtained by the punch operation was imperfect, and a second attack was made with it upon the median portion of the prostate, thus giving satisfactory results.

In the other 63 cases the single punch operation has been radical in its removal of the obstruction, and the results obtained—even as regards the painful and neurotic symptoms—have been highly satisfactory. In most cases no subsequent treatment of the prostate has been

given, but in others, especially those associated with marked prostatitis and pain, local treatment as outlined elsewhere has been employed.

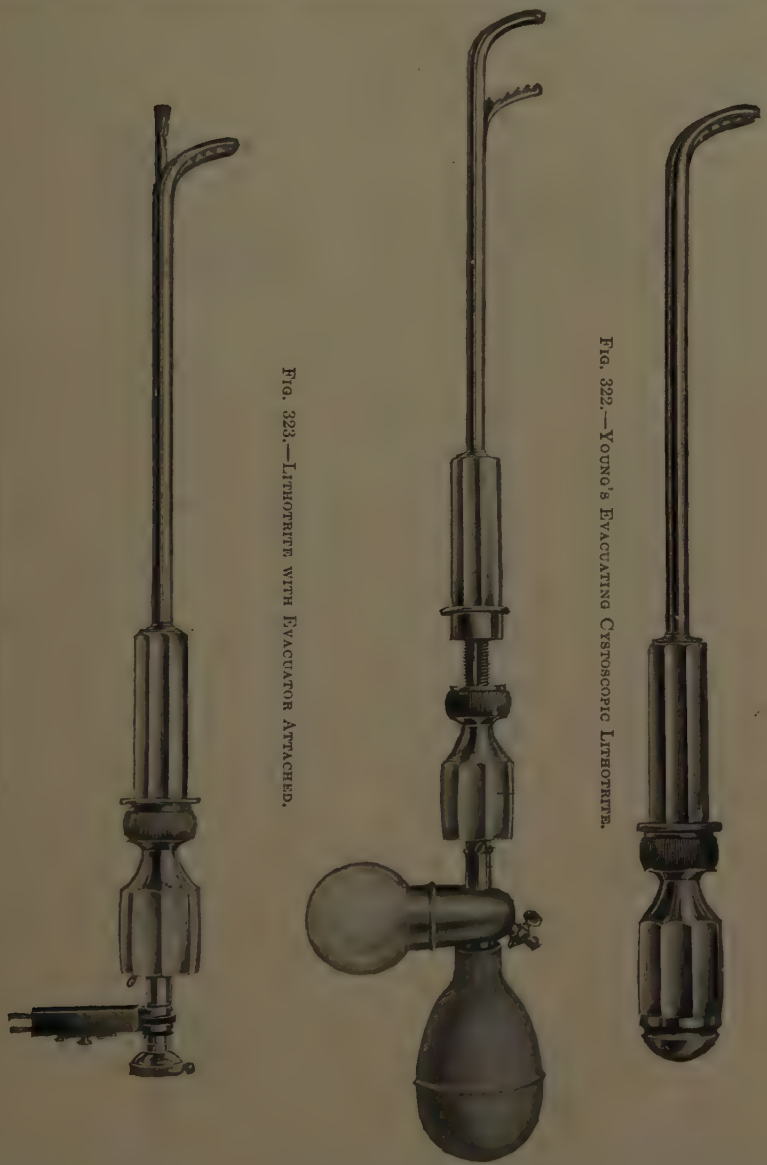

Fig. 324.—Lithotrite with Cystoscope Inserted.

Fig. 323.—Lithotrite with Evacuator Attached.

Fig. 322.—Young's Evacuating Cystoscopic Lithotrite.

In summarizing I may say that the relief of obstruction obtained has been just as complete as after prostatectomy, and it has not been found advisable to employ urethral dilatation afterward.

The removal of a small rounded or pedunculated intravesical prostatic lobule may be accomplished by means of the "punch" above

described, even when situated in other than the median portion of the prostate, by simply turning the instrument in the desired direction, after it has entered the bladder, removing the obturator, and withdrawing the instrument until the lobule drops into the fenestra. By evacuating the fluid in the instrument a view of the imprisoned lobule can be seen before it is removed by the inner cutting tube. This instrument has

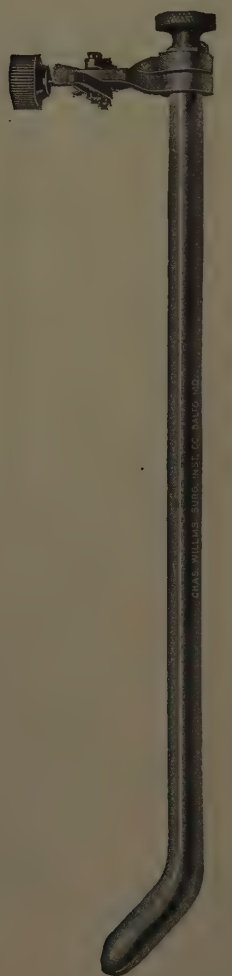

Fig. 325.—Cystoscopic Rongeur, Closed; Ready for Introduction, Obturator in Place.

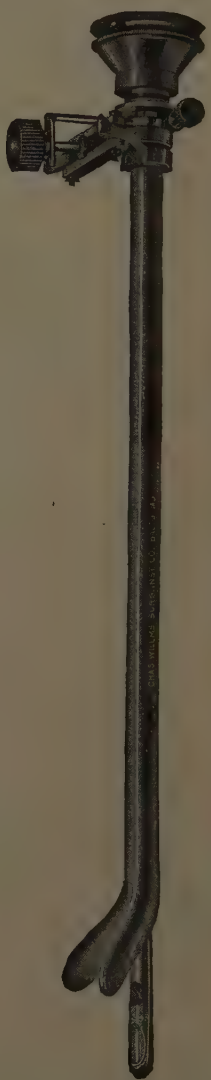

Fig. 326.—Cystoscopic Rongeur, Open; Cystoscope in Place, Ready for Use.

been used, as just described, to cure several cases with small pedunculated median or lateral lobules, urethral polyps, fringes around the prostatic orifice, and obstructing bars or lobules left after suprapubic or perineal prostatectomies which have been incompletely done. When the lobe is quite pedunculated and intravesical it can generally be more

readily removed in one piece by means of my "cystoscopic rongeur" shown in Figs. 325 and 326. With this rongeur it is possible to grasp and remove lobules 2 cm. in diameter. When drawn through the urethra the tissues become compressed and elongated, so that large masses may come through the urethra without difficulty. It is often advisable, after removing a pedunculated median lobe with the rongeur, to excise the bar beneath it with the punch in order to completely remove the obstruction, and also to divide a contracted internal sphincter. I wish to lay stress upon the fact, however, that neither of these procedures is suitable for general hypertrophy of the prostate, for which prostatectomy is the operation of choice, but for the localized lesions at the prostatic orifice—viz., bars in the median portion of the prostate, contracted sphincters (contracture of the neck of the bladder), small isolated prostatic lobules, intravesical or intraurethral, not associated with hypertrophy of the lateral lobes—they are ideal. Careful cystoscopy, of course, is an absolute prerequisite.

When properly restricted to carefully studied, well-chosen cases the "punch" operation is very radical and permanently curative, and is by far the simplest and safest procedure for cases of this type of obstruction, which are far from uncommon, having been about one-third as frequent as true hypertrophy in my practice during the past three years.

Tuberculosis of the Prostate.—Recent work of Whiteside brings new hope that we may yet have satisfactory results from operations upon the tuberculous prostate. Whiteside's cases were very severe, and the operation—perineal prostatectomy—was performed with the hope of relief from very painful and frequent urination, and the results obtained were remarkably satisfactory.

I have recently had similar excellent results, and I am inclined to think that we may yet come to an operative treatment for certain cases. One of the greatest objections to the operation in the past has been a persistent tuberculous urinary fistula, which usually resulted. I have recently devised a prostatic tractor sufficiently long and delicate to be passed through the entire urethra into the bladder with the object of doing away with the incision into the membranous urethra, which has been necessary with the usual prostatic tractor. With this instrument it is possible to get excellent traction upon the prostate, and to expose for operation the posterior surface of the prostate and the seminal vesicles, through the usual perineal prostatectomy cutaneous incision, and without division of the levator ani muscles. It is then not difficult to remove the lateral and median portions of the prostate, and the seminal vesicles, vasa deferentia, and ejaculatory ducts without opening the prostatic urethra or the bladder. In exposing the seminal vesicles it is necessary to divide Denonvillier's fascia, which is closely applied to their posterior surfaces, after which they can be easily isolated. By avoiding the blood-vessels which lie along the outer edge of the seminal vesicles little difficulty is experienced in controlling hemorrhage.

The recent advances made in the use of tuberculins, and the many brilliant results which have been obtained, make one cautious in advis-

ing operative procedures. Tuberculin injections have proved most satisfactory where operations like nephrectomy or epididymectomy have removed a considerable portion of the tuberculous process. After such operations the human organism is often able, under good hygienic treatment, to throw off the rest of the disease, but the use of tuberculin in increasing doses, but so small as not to give reactions, is often of great help. For a valuable symposium on this use of tuberculin in such cases see Transactions of the American Congress of Physicians, 1909.

Prostatic Hypertrophy.—The past four years have added much literature to the question of prostatic hypertrophy, but very little that is new. Among the most important may be mentioned papers by Freyer,[1] Wolff,[2] Tandler and Zuckerkandl,[3] Squier,[4] Young,[5] Marion,[6] Wilson and McGrath,[7] and Bryan.[8]

At the International Congress of Urology which was held in London, 1911, a very complete discussion of the various aspects of prostatic hypertrophy and the operations therefor was held, and the transactions of this society show the very varied views which were held by the various nationalities represented there.

In the field of pathology the most striking announcements have been those of Marion, who holds that prostatic hypertrophy is due solely to glandular overgrowth of the periurethral glands which immediately surround the prostatic urethra, and those of Tandler and Zuckerkandl, who hold that prostatic hypertrophy is due to an enlargement of that portion of the prostate between the verumontanum and ejaculatory ducts and the vesical orifice—the so-called median portion of the prostate, and that the enlargements which occur on each side of the urethra are simply due to prolongation of the median growth upward on each side of the urethra. The work of Tandler and Zuckerkandl is based upon a dissection of 42 postmortem cases. Although they come to the conclusion that suprapubic prostatectomy is the proper method of removal, their conclusions as to the region involved are absolutely at variance with those of Freyer, who after an experience of many hundred suprapubic prostatectomies stated that the enlargement was always of the lateral lobes, and that the median lobe was merely a backward outgrowth from one of the lateral lobes.

The whole question is, in our opinion, merely one of interpretation, and no correct deduction can be drawn by viewing late prostatic enlargements such as have been studied by Tandler and Zuckerkandl. In a

[1] The Lancet, 1909–1911.

[2] Ueber die bosartigen Geschwülste der Prostata insbesonders ueber die Karzinome derselven, Deut. Zeit. f. Chir., Bd. 53.

[3] Anatomische Untersuchungen über die Prostatahypertrophie. Die Wunde und der Heilungsvorgang nach Extirpation der hypertrophischen Prostata. Folia Urologica Internationales, Archiv. für Krankheiten der Harnorgane, March, 1911.

[4] Surg., Gyn., and Obstet., 1911.

[5] Cancer of the Prostate, Annals of Surgery, 1909, vol. i., pp. 1144–1233; Surg., Gyn., and Obst., 1911; Trans. Internat. Assoc. Urologie, 1911.

[6] Annales des Maladies des Org. Gen. Urin., 1911.

[7] Surgical Pathology of the Prostate. A Review of 468 Cases, Surg., Gyn., and Obstet., December, 1911.

[8] Surg., Gyn., and Obstet., 1912.

recent study of the embryology of the prostate at birth, Lowsley has shown that the glandular portions of the prostate develop from five separate foci, one on each side (the lateral glandular groups), one anteriorly, one posteriorly above the verumontanum, and one beneath the verumontanum and ejaculatory ducts. These are all separated more or less definitely by planes of fibrous tissue, the demarcation between the lateral portions and that beneath the ejaculatory ducts and verumontanum being quite pronounced so as to separate the two portions very distinctly. The latter portion very rarely shows any evidence of hypertrophy, but in the other four portions isolated lobules of adenomatous hypertrophy are frequently seen, so that it is ridiculous to hold, as Tandler and Zuckerkandl do, that the median portion of the prostate alone is the beginning point of adenomatous hypertrophy which invades the lateral and other portions of the prostate. Several years ago I pointed out that in approaching the prostate through the perineum one had always to pass through a layer of compressed non-hypertrophied prostatic tissue which represented that group of glandular development beneath the ejaculatory ducts. I also pointed out that this was most apt to be the site of beginning carcinoma of the prostate. As soon as this posterior layer is incised on each side, as in the operation I have described, the bulging mass of the lateral hypertrophies at once appears, and no difficulty whatever is experienced in enucleating them through the perineum, and in also drawing after them a median enlargement, even though it may project greatly into the bladder. I cannot, therefore, agree with the anatomic and postmortem conclusions of Tandler and Zuckerkandl that the suprapubic route is the only method by which enlargement of the prostate should be removed; in fact, since a good many of their specimens show that prostatic hypertrophy is often not accompanied by an intravesical outgrowth or even with dilatation of the internal sphincter, it seems evident that there are many cases which should not be attacked by the suprapubic route. Freyer has acknowledged this in several of his writings, in which he clearly states that one should not attempt to enucleate a prostate (suprapubically) unless there is a projecting lobule in the bladder. I have not space here to go further into these interesting questions of etiology and pathology, but I refer the reader to Vol. IV., p. 372, where my ideas have already been thoroughly expounded.

Operative Treatment.—The extensive literature, with exhaustive studies of ultimate results and the thorough discussion of the subject by representatives from various countries at the International Congress of Urology in London in 1911, has shown a considerable change of opinion as to the proper method of operative attack for prostatic hypertrophy. The results of these studies and discussions may briefly be said to have demonstrated the following conclusions:

Many surgeons who have been performing the Goodfellow perineal operation have found, with the small incision in the bulbous urethra and blind removal, piecemeal, of the prostate, that intravesical portions of the median or lateral lobes often escape them and have led to a rapid recurrence of obstruction. Incontinence of urine has also been a not

infrequent result, due to the traumatism to the external sphincter and triangular ligament.

Those who have followed the methods of perineal prostatectomy of Proust or of Albarran, in which no tractor was used, have found that the extensive dissection required has led not infrequently to incontinence of urine, epididymitis, loss of sexual powers, and also to incomplete removal of the prostate because the intravesical portions were not reached, as there was nothing employed to draw them down into the field of operation.

The reason for the failure by these various methods of attack, and consequent abandonment of the perineal route was due, not so much to the difficulties of attacking the prostate through the perineum, as to the fault of the operators in not having due regard to important anatomic structures.

Suprapubic prostatectomy now has the most advocates, due, I believe, to the bad results coming from faulty perineal technic described above. In the field of suprapubic prostatectomy two distinct types of operative technic were brought forth: that of the English school, who believe in a small suprapubic incision, large enough only to admit of the insertion of two fingers into the bladder, enucleation of the prostate by blunt dissection with the aid of the finger in the rectum, the prostate being removed in one mass, generally with the anterior commissure and that portion of the urethra above the verumontanum and ejaculatory ducts,—the so-called method of Freyer.

The other method is that usually employed by the French and Germans, characterized by a large suprapubic incision, wide exposure and retraction of the bladder; incision with a scalpel through the mucous membrane and capsule over the projecting portions of the prostatic lobes, and the enucleation separately or piecemeal of the various portions of the prostate, accompanied in some cases by suture of the mucous membrane over the prostatic wound. The advantages claimed by the former method are that it is a much quicker operation that ought to be done in five to ten minutes, and is accompanied by a mortality in the hands of Freyer, its greatest exponent, of 47 deaths in 800 cases, a mortality of 5.8 per cent., whereas the mortality rate of Zuckerkandl, the exponent of the more open dissecting method, is about 20 per cent.

A third method of suprapubic prostatectomy is that which has been recently advocated by Squier. He follows Freyer in making a small suprapubic and also a small vesical incision. The index-finger in the bladder, instead of being made to break through the capsule of the most prominent portion of the prostate, is inserted far into the urethra until the anterior portion of the lateral enlargement is felt, then the tear is made boldly through the urethral mucosa upon the enlarged lobe, which is then separated from its capsule, the procedure being continued first on each side and then posteriorly until the three lobes are delivered into the bladder. This technic may be said to be just the opposite to that of Fuller and Freyer, who approach the enucleation from behind forward. Squier claims for this method a quicker operation, less

traumatism, less removal of capsule, and no more destruction of the urethra.

A fourth method of prostatectomy, *i. e.*, by the perineal route, is that which has been employed by myself since 1898, which consists in first separating by blunt dissection the lateral lobes from the urethra, which is pushed inward and upward. The finger is then swept around the lateral portions of the enlargement, which are then delivered with the median lobe into the bladder. This leaves the urethra hanging by the anterior commissure, and in numerous specimens I am able to show that practically all of the posterior urethra is thus preserved, giving, I believe, the advantage of a quicker healing.

The discussion in London and recent literature have brought forth the fact that incontinence of urine, stricture or even complete obliteration of the posterior urethra, and permanent fistula do follow suprapubic prostatectomy, and, judging by the reports of cases, not so rarely as previously supposed. The first are due to too extensive an operation, the capsule of the prostate being removed with the hypertrophied lobe, and the persistent fistula to leaving some of the prostatic obstruction behind.

The statistics which I presented in London showed 17 deaths in 450 cases of perineal prostatectomy for benign hypertrophy. Of these there was only 1 death within the first twenty-four hours, and 3 within the first week after the operation. There were only 3 cases of partial incontinence, and none of complete incontinence. Injury to the external sphincter was apparently responsible, and should have been avoided. Two recto-urethral fistulæ were present among the early cases. In only 4 cases has there been a complete return of the obstruction, and review of these cases shows that they belong to the small sclerotic variety which have since been shown to be best treated by the " punch " operation.

In one series of 128 consecutive cases there were no deaths, and the results obtained seem to show conclusively that conservative perineal prostatectomy is the safest and most satisfactory operation for either benign or carcinomatous enlargement of the prostate.

Renal Function.—In determining when a patient suffering with prostatic disease can be operated upon safely, perhaps the most important information desirable is as to the functional ability of the kidneys. For many years I have been certain that the ordinary tests are entirely inadequate to give an accurate idea of the condition of the kidneys, for, not infrequently, with urine of good specific gravity, no infection, almost normal urea, and total solid content, further developments in the case would show that the kidneys were markedly impaired. Clinical experience has demonstrated that not infrequently in cases of long-standing prostatic obstruction with a large amount of residual urine the ordinary urinalysis before the patient had been catheterized would show fairly normal urine, but if the patient were operated upon at once without preliminary treatment dangerous or even fatal uremia was very apt to supervene, so that I learned by experience to avoid an early operation on such patients with much residual urine, who had not been

regularly catheterized for a protracted period. In these cases I adopted a routine preliminary treatment consisting of frequent or continuous catheterization, water in abundance, urotropin, etc. During the past ten years I have frequently tried various functional tests—phloridzin, indigo-carmin, the freezing-point, etc.—but with no very satisfactory results, so that until the demonstration in 1909 of the value of phenol-sulphonephthalein (which had been discovered several years before by Ira Remsen) in showing the functional activity of the kidneys, I was forced to rely on the ordinary methods of clinical examination. Abel and Rowntree showed that following a subcutaneous injection of a small amount of phenol-sulphonephthalein it appeared in the urine inside of ten minutes. It appears in the bile, but is reabsorbed from all parts of the intestines, and only a trace of it can afterward be found in the stool. Practically all of it is excreted through the kidneys, and very rapidly. A careful clinical study of the effects of the drug has been made by Rowntree and Geraghty upon patients in the urologic service of the Johns Hopkins Hospital, and practically all of my cases of enlarged prostate have been subjected to the test. When a 6 mg. dose is injected intramuscularly it has been found that the time of appearance varies from five to ten minutes, seven being the average; that from 40 to 60 per cent. of the drug is excreted during the first hour after its appearance in the urine, and from 20 to 25 per cent. in the second hour. At first subcutaneous injections were used; later, intramuscular injections were tried, and it has been shown that the drug appears more quickly, and the amount excreted in one and two hours is a little greater with intramuscular than with subcutaneous injections. Very recently we have been experimenting with intravenous injections. The standard dosage has been 6 mg. of phenol-sulphonephthalein. The patient is given 3 glasses of water to drink, and is then catheterized and the bladder washed out just before inserting 1 c.c. of fluid containing 6 mg. of the drug intramuscularly or intravenously. The time of appearance of the first faint pinkish tinge as the urine escapes from the catheter into the test-tube, made alkaline by adding a drop of 25 per cent. NaOH solution, is noted as the beginning of the test. The urine is then collected in one receptacle for one hour, and in another receptacle for another hour, and, by means of a modified Hellige hemoglobinometer, the amount of phenol-sulphonephthalein which has been excreted during the two hours can be readily determined with great accuracy.

The great value of the phthalein test is shown in a study of 76 cases which I have grouped according to the amount of residual urine, and use or non-use of a catheter. This analysis brings out clearly the bad effect of long-standing residual urine of large amount which has not been relieved by regular catheterization.

Those patients who had not been catheterized and in whom a large amount of residual urine had been present for a long time showed marked impairment, and 3 died of uremia, 1 a cancer case. The wonderful improvement possible by preparatory treatment, consisting of regular

or continuous catheterization and water by mouth, rectum, or subcutaneously, is shown by many cases in which the appearance time became greatly lessened, and the output of phthalein greatly increased by preparatory treatment lasting from two to six weeks.

Patients with much residual urine who had used a catheter for a month showed less renal impairment, but those who had followed a catheter life for a long period showed in 7 out of 9 cases good renal function. In 2 cases the phthalein test showed marked impairment, and it did not become good after prolonged catheter treatment, but numerous tests seemed to show that the condition was stable, and that there was no likelihood of acute suppression coming on after operation. These conclusions were proved correct by the postoperative convalescence, which was very satisfactory. Patients with moderate residual urine (150 to 250 c.c.) showed, as a rule, little renal impairment as a result of back pressure, but those who had used a catheter were generally better prepared for an early operation.

The great accuracy of the phthalein test was shown in a case in which the ordinary urinalysis gave no evidence of renal impairment, viz.: urine specific gravity 1010 to 1012, output 2000 c.c., and urea 20 to 30 gm. in twenty-four hours, a slight trace of albumin, microscopically a few pus-cells, bacilli, no casts. An injection of 6 mg. of phthalein resulted in the elimination of only the faintest trace of the drug, repeated tests being made on succeeding days. The patient did not improve on the preparatory treatment, but rapidly became uremic and died in three weeks, autospy showing marked atrophy of both kidneys, neither of which was one-third the normal size, marked dilatation of the ureters and renal pelves; microscopically, chronic interstitial nephritis.

When the question of operation arises in case of enlarged prostate one should determine not only the size, shape, and character of the prostate, the possibility of malignancy, the amount of residual urine, and the condition of the bladder, but, above all, the functional value of the kidneys, what effect the prostatic obstruction may have had, and what the probabilities as to uremia and suppression of urine after operation are.

Cases with considerable residual urine and definite impairment of the kidneys should be put on preparatory treatment, consisting of regular catheterization three or four times daily with a coudé gum catheter and water in large quantities by mouth. Hexamethylenamin should also be given to prevent infection, 40 to 60 gr. daily. Phthalein tests should be made every three or four days to watch the renal improvement.

The time at which the operation can be safely performed is to be determined by the improvement in the appearance time and output in two hours, or the stability of the renal function, the presence or absence of uremic signs and symptoms, and a careful general study of the case after protracted treatment. No hard-and-fast lines can be drawn because some cases of chronic nephritis of long standing may give bad

phthalein tests, and yet be in no great danger of uremia if operation is undertaken.

A poor phthalein test should indicate preparatory treatment, but almost all cases can be brought into condition sufficiently good for perineal prostatectomy, as shown by the fact that during a period of fifteen months I saw 79 cases, all but three of whom were operated upon. Two of these 3 patients died of uremia while under preparatory treatment, autopsy showing severe nephritis in both cases. In the third case the renal function, while much impaired, was not as bad as in some of the cases operated upon successfully, but the heart action was so extremely weak and irregular that operation was not advised.

Carcinoma of the Prostate.—During the past four years the frequency and importance of carcinoma of the prostate has received much attention in the splendid articles of Wolff, Bryan, and Wilson and McGrath. In my own practice the frequency of carcinoma has very greatly increased in recent years; starting with about 10 per cent., it has now reached about 30 per cent., that is, in 3 cases presenting themselves for cure of prostatic obstruction, 1 is found to be carcinomatous. Wilson and McGrath state that in an examination of 468 specimens removed by prostatectomy there were 73 which were carcinomatous, 15.5 per cent. Had the advanced cases of carcinoma been operated upon, unquestionably their percentage would have been very greatly increased, probably up to that of my series, in which non-operative cases are included, there being now about 200 cases of carcinoma to 500 cases of benign hypertrophy.

In my first series of cases carcinoma and hypertrophy of the prostate seemed to occur very seldom together. Subsequent studies show that in about half of the cases hypertrophy of the lateral lobes is present. In such cases the cancer is usually confined to the posterior stratum of tissue between the posterior capsule and the lateral lobes, and in most cases the cancerous infiltration progresses upward around and into the seminal vesicles and vasa deferentia without involving the hypertrophied lobules in the lateral and median portions of the prostate, the firm capsules of which seem to prevent or retard invasion. In 13 of my cases the hypertrophied lateral lobes, although adjacent to a broad posterior stratum of cancer, remained free from invasion. There is an intermediary transverse layer of connective tissue which always lies posterior to the lateral lobes in hypertrophy, and generally anterior to the above-described posterior subcapsular layer of cancer when this coexists. It seems to be a remarkable fact that cancer generally begins posterior to this layer of connective tissue, and hypertrophy always in front of it.

In some of our specimens the cancer cells are found invading the hypertrophied lobes, and in a few they have almost completely replaced the hypertrophy, the encapsulated lobulation, however, being more or less preserved.

Early or beginning cases of cancer of the prostate are rarely seen at operation or at autopsy. I have had 3 such cases. One at autopsy, in which a nodule of cancer was found in the anterior commissure of the

prostate, the lateral and median lobes of which were considerably hypertrophied. In the other 2 cases a single small nodule was found. In 1 case it was very small—about 2 mm. in diameter, and was only discovered on microscopic examination. The patient had been subjected to a conservative perineal prostatectomy, large adenomatous lobules being removed. The tissue surrounding this nodule of very definite carcinoma showed no adenomatous changes, but ordinary prostatic tissue with well-marked periacinous inflammation. In the other case a nodule of carcinoma 1 cm. in diameter was found in the substance of one lateral lobe. There were no adenomatous spheroids present, and microscopic examination showed chronic prostatitis of the lateral lobes which had been removed. The cancer was completely excised in both of these cases, as shown by the fact that both patients are well almost four and eight years later.

In 89 cases in which the bladder was examined, either at operation or by the cystoscope, there were only 3 cases in which intravesical tumor outgrowths were present. These statistics seem to controvert those of Motz who claimed that there was a frequent association between carcinoma of the bladder and prostate. It is true that in 28 of my cases the trigone was elevated or thickened, and, in all probability, partially infiltrated from the retrovesical intervesicular mass of carcinomatous invasion. That such retrovesical invasion rarely leads to intravesical tumor formation seems also abundantly shown by the studies of Kaufmann.

In only 7 cases did the cystoscope show considerable hypertrophy of the lateral lobes intravesically, but in 20 cases the median portion was enlarged either in the shape of a bar or rounded lobe.

In Vol. IV., p. 464, I described two methods of operation for carcinoma of the prostate. First, was the radical operation, in which the prostate with urethra and capsule with the neck of the bladder and the seminal vesicles was removed in one piece. This was followed by an anastomosis between the stump of the membranous urethra and the anterior wall of the bladder. This operation has now been carried out seven times, with one operative death. The immediate results were described in the previous article. One patient lived six and a half years, and during this time reported to me frequently by letter, and was examined twice. At the last report, a short time before his death he reported that he was entirely cured. He died in the autumn of 1911, six months after his latest report, and I have been unable to obtain any information as to the cause of death. In a second case four years have elapsed since the operation, and the patient is apparently well.

The great difficulty with the radical cure of prostatic carcinoma is that it is extremely rare to get the patient early enough for this operation. Unfortunately, the disease is usually so insidious and painless in its early stages that before the patient comes to the surgeon for operation the seminal vesicles and structures above the prostate are already involved so that all hope of a radical cure is out of the question. If physicians could be induced to make prostatic examinations regularly as a routine in physical diagnosis, and should learn to be suspicious of induration of

the prostate even of moderate degree when no symptoms are present, many early cases of carcinoma of the prostate would be detected and brought to an early operation. If such conditions could be brought about the hope of radical cure would be splendid in many cases, as the prostate is thoroughly encapsulated and the carcinomatous growth slow of development and few in its metastases.

Recent years have shown the very great value of conservative enucleating perineal prostatectomy in cases of carcinoma of the prostate where it is manifestly impossible to do a radical operation.

A further study of the ultimate results, made in the spring of 1911 and presented to the International Congress of Urology in London, showed as follows:

There were 10 cases in which the functional result was perfect as long as the patient lived (and 1 patient lived three and a half years and 2 over two and a half years with no return of the urinary obstruction). Twelve patients were still alive and apparently well (*i. e.*, free from obstruction to urination), 7 of them having been operated upon more than one year before. Two of these cases are now alive, one eight years and the other four years after operation, and are apparently entirely cured. Both of these were very early cases, the cancer being entirely circumscribed and completely removed in each case. Microscopic examination showed only a small nodule of carcinoma entirely surrounded by the healthy tissue of a lateral lobe in each case, and I, therefore, feel confident that a radical cure has been obtained in these 2 cases. In the other 10 cases of this group the disease had spread far above the prostate before operation was performed, but the functional results obtained by conservative prostatectomy have been excellent. In 3 cases there was a partial, and in 7 cases a complete, recurrence of obstruction after operation. A review of these 10 cases shows that the operative technic was faulty in several, in that the median portion of the prostate had not been adequately excised. Experience has shown that it is very important to dilate widely the vesical orifice, which is often markedly contracted by a fibrous-like ring, and also to remove with the curette the subcervical and prespermatic carcinomatous infiltration in order to secure permanent relief of obstruction.

There have been 2 deaths among the 34 patients who were subjected to the operation of conservative perineal prostatectomy for carcinoma of the prostate. Both of these patients were very sick before operation, and they died during the fourth week after operation of uremia and cachexia.

In conclusion, it may be confidently stated that in advanced cases of cancer of the prostate, characterized by marked difficulty or frequency of urination, or those in which a catheter life is difficult or painful, the therapeutic method of choice is perineal prostatectomy with careful preservation of the urethra and vesical mucosa, but with complete removal of the lateral and median portions of the prostate and thorough dilatation of the vesical sphincter. Excellent results, maintained as long as the patient lives, can apparently be expected in about 60 per cent. of the cases.

CHAPTER CXXXVI.

TREATMENT OF GONORRHEA AND ITS COMPLICATIONS WITH GONOCOCCUS VACCINE AND ANTIGONOCOCCUS SERUM.[1]

By Orville Horwitz, M. D.,

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This method of treatment is still in the experimental stage. The report of numerous observers is very discouraging, and the study of an extensive literature on the subject leaves the reader in doubt as to whether this method of therapy has any merit or is merely beneficial in a few selected cases. No conclusive evidence can be obtained as to the real value of either the vaccine or serum method of therapy. Nothing definite is known about the size of the dose or the frequency of its administration. Every writer on the subject advises differently and appears to be guided by his own experience. In my experience it makes no difference where the injections are given; their administration always gives more or less pain, generally moderate, but sometimes severe and persistant. At the site where the injection or vaccination has been made the skin becomes congested, occasionally marked swelling with redness arises, attended by a burning sensation or intense itching of the skin. In no instance have I had an abscess form. Local and inflammatory symptoms more frequently occur from the serum than from the vaccine. The vaccine frequently leaves a small amount of induration. The constitutional symptoms that have been observed in a few cases are anorexia, malaise, and a sense of constriction about the thorax which generally soon subsides, though it may persist for a few days and cause the patient discomfort and anxiety.

I have never seen any serious complications arise from either vaccination or injection. Neither vaccine nor serum renders the patient immune. Relapses after treatment are common and reinfections frequently occur.

The dosage of vaccine is still an unsettled question. My experience coincides with that of Louis E. Schmidt,[2] who states: "In my belief small doses, say, from 10,000,000 to 50,000,000, repeated at short intervals, are far more effective than the larger doses of 75,000,000 to 150,000,000." He goes on to say that in acute or chronic cases the minimum dose should be given, which should be gradually increased

[1] Supplementary to Chapter LX., Vol. IV., p. 473.
[2] Therapeutic Gazette, September, 1910.

according to the effect produced. The maximum dose should be given at lengthened intervals and reserved for chronic cases. The largest dose that Schmidt has administered was 165 c.c. of the serum and 1,400,000,000 of the bacteria. I have had no experience in such enormous dosage, and, therefore, cannot say anything definite about the effect of such heroic treatment. My custom is to administer the serum in 2-c.c. doses, given daily for a week, then, after five days' intermission, again for seven days. This method of treatment is carried out for three or four weeks. In a few selected cases I have given 4 to 8 c.c. at six-days intervals without observing any constitutional disturbance.

During the past four years a careful study of 211 cases of gonorrhea and its various complications has been made in the Out-patient Dispensary of the Jefferson Medical College Hospital, with the following results:

Case.	Vaccine.	Serum.
Acute uncomplicated urethritis	10 cases, no result.	10 cases, no result.
Chronic urethritis	10 cases, no result.	10 cases, no result.
Acute posterior urethritis	5 cases, no result.	5 cases, no result.
Acute seminal vesiculitis	4 cases, no result.	4 cases, no result.
Acute orchitis or epididymitis	10 cases, no result.	10 cases, no result.
Subacute delayed convalescence	8 cases, no result.	8 cases, 3 benefited.
Cystitis, acute and chronic	10 cases, no result.	10 cases, no result.
Conjunctivitis	2 cases, no result.	3 cases, no result.
Arthritis	12 cases, no result.	12 cases, 3 benefited.
Acute and chronic arthritis	10 cases, no result.	20 cases, rapid improvement in 10, slight improvement in 6.
Myo-endocarditis with valvular lesions.	2 cases, no result.	6 cases, marked benefit in 2, rapid recovery in 1 desperate case, 3 unimproved.
Gonorrheal toxemia	2 cases, no result.	3 cases, all benefited, 1 cured.
Periurethral abscess with sinus	1 case, no result.	2 cases, no result.
Balinitis	2 cases, no result.	3 cases, no result.
Vaginitis	4 cases, no result.	4 cases, no result.
By permission of Gynecologic Department	4 cases, chronic gonorrheal affection of tubes and ovaries, no result.	5 cases, no result.

A study of this number of cases shows that 96 were vaccinated, and in 115 patients serum was injected. I feel justified in drawing the following conclusions: First, beyond occasionally relieving cases suffering acute pain, vaccination was worthless; second, the serum is of service only occasionally in severe cases of epididymo-orchitis and gonorrheal myocarditis; third, in acute and subacute arthritis it should always be used as a routine treatment; fourth, in those rare cases of pure gonorrheal toxemia it is invaluable.

A study of this table shows that out of 211 cases treated, 22, or $10\frac{3}{7}$ per cent., were cured; 9, or $4\frac{2}{9}$ per cent., were improved, leaving 180, or $85\frac{3}{10}$ per cent., uncured.

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CHAPTER CXXXVII.

LABYRINTHINE AND PERILABYRINTHINE INVOLVEMENT DUE TO ACUTE OR CHRONIC MIDDLE-EAR SUPPURATION.[1]

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Involvement either of the labyrinth or perilabyrinth, as the result of an acute or chronic middle-ear suppuration, is ordinarily evidenced by, first, a disturbance of the equilibrium; second, nausea and vomiting; third, nystagmus; fourth, by profound impairment of hearing.

While cases of labyrinthitis and perilabyrinthitis may follow an acute middle-ear inflammation, they are much more prone to follow a chronic suppurative otitis media. In any given case it is often difficult to determine, prior to operation, whether the labyrinth itself is involved or whether the suppurative inflammation has involved simply the perilabyrinthine structures, that is, the diploic bone which surrounds the bony labyrinth. A perilabyrinthitis may give rise to symptoms which simulate almost exactly those of an inflammation of the labyrinth. It is difficult to explain the cause of the labyrinthine symptoms in cases of perilabyrinthitis. Probably, however, the suppurative process in the immediate neighborhood of the labyrinth causes certain circulatory changes in the labyrinth itself, possibly an effusion of serum into the labyrinth; in other words, a true serous labyrinthitis. As the result of this serous effusion the circulation of the fluid in the semicircular canals and cochlea is interfered with, and symptons characteristic of interference with the labyrinthine function make their appearance.

Cases of perilabyrinthitis are usually characterized by impairment of function of the labyrinth alone, that is, by profound impairment of hearing, nystagmus, and vertigo. Elevation of temperature is seldom or never seen in these cases. When the labyrinth itself is involved in a true suppurative inflammation, in addition to the profound impairment of hearing and the disturbance of equilibrium, we have an elevation of body temperature, moderate or extensive, according to the degree of the inflammation.

In cases of a serous effusion into the labyrinth, dependent upon a perilabyrinthitis, elevation of temperature seldom occurs. If the labyrinth is involved in suppurative inflammation, elevation of temperature will depend upon the extent of involvement. A diffuse suppurative labyrinthitis is really the first stage of an acute meningitis in these cases,

[1] Supplementary to Chapter LXIV., Vol. IV., p. 797.

consequently we have either a sudden rise of temperature to 102° or 103° F., or a rise of temperature to 101° or 102° F., which gradually progresses from day to day, until the temperature reaches 103°, 104°, or 105° F., at which time the labyrinthitis has become a meningitis.

Where a circumscribed area of the labyrinth is invaded, as, for instance, where a suppurative process invades the horizontal semicircular canal, we may have vertiginous symptoms and profound impairment of hearing, together with a slight rise of temperature (from 100° to 101° F.). If nature is able to wall off the infected area, these symptoms gradually disappear. The labyrinth resumes more or less completely its normal function, the temperature falls to normal, the vertigo and nausea disappear, and the patient's condition becomes practically normal as far as the ear is concerned, usually with considerable impairment of hearing.

Before going further into the symptomatology of inflammations of the labyrinth, certain normal physiologic reactions of this portion of the auditory apparatus must be remembered. The labyrinth is composed, as we know, of two portions, a static and an auditory portion. From the location of the static portion of the labyrinth this portion is much more prone to invasion as the result of a suppurative process within the middle ear or mastoid than is the auditory portion. For instance, the horizontal semicircular canal forms the floor of the *aditus ad antrum*, and in cases of acute and chronic middle-ear suppuration is practically continually bathed in pus. The vertical semicircular canal is in immediate relation with the tympanic vault, while the posterior semicircular canal is so situated as to be constantly menaced in cases where extensive destruction of the deeper mastoid cells, between the facial ridge and the lateral sinus, has taken place. The oval and round windows, although apparently less protected than the situations above named, are really much better protected, because drainage from the middle ear keeps these regions fairly free from the purulent collection, while the semicircular canals are constantly exposed to infection on account of imperfect drainage through the middle ear. For this reason, therefore, invasion of the labyrinth takes place most commonly through the horizontal semicircular canal, and less frequently through the oval and round windows. The posterior and superior canals, being more thoroughly protected by the bony coverings which surround them, are less frequent sites of invasion.

As before stated, the static portion of the labyrinth is the part most commonly invaded primarily, and, consequently, it is by testing the static portion of the labyrinth that we derive the most valuable information regarding beginning labyrinthine involvement in these cases.

The symptoms of labyrinthine involvement are, first, vertigo; second, nausea and vomiting; third, nystagmus; fourth, profound impairment of hearing.

The vertigo in these cases is usually quite severe. The patient is frequently unable to stand upright, and sometimes is unable to assume even the sitting posture without falling.

The nausea and vomiting vary. In cases of a very acute type the patients may vomit violently or, in the less severe cases, they may be simply nauseated.

Nystagmus is a fairly constant symptom in cases of labyrinthine and perilabyrinthine involvement. The character of the nystagmus depends upon the particular semicircular canal involved. It is ordinarily a horizontal nystagmus, but may be rotatory. In the early stages of the disease this nystagmus is usually more marked in looking to the diseased side. As the perilabyrinthine or labyrinthine inflammation advances, however, nystagmus toward the diseased side disappears, and there is a well-marked nystagmus on looking toward the healthy side. Such a nystagmus ordinarily indicates that the function of the labyrinth upon the affected side is temporarily ablated. The impairment of hearing is usually very profound, varying from the ability to hear the moderate voice close to the ear to total deafness.

In order to comprehend clearly labyrinthine and perilabyrinthine involvement following an acute or chronic middle-ear suppuration it is necessary to review briefly certain well-known physiologic facts regarding the labyrinth:

The labyrinth is divided into two portions, the static and the auditory; the static being represented by the semicircular canals and the auditory by the cochlea. While tests indicative of impairment in function of the acoustic labyrinth, such as interference with the upper tone limit and impairment of bone conduction, have been recognized for a number of years, it was not until 1906 that the investigations of Barany[1] and Neumann,[2] taking advantage of the experimental work of Hoyges, enabled us to conduct tests which would determine involvement of the static labyrinth.

In order to test the integrity of the static labyrinth we have two methods at our disposal: first, the rotation test; second, the caloric test. It has been demonstrated that if a patient is rotated with the head erect for a certain number of times, say, for ten rotations, and if the rotation is then suddenly stopped, that under normal conditions a horizontal nystagmus will be developed if the patient looks in the direction opposite to rotation, and that this nystagmus will persist for from twenty-five to thirty seconds. Thus, if the patient is placed in a chair and rotated to the right, that is, in the direction of the rotation of the hands of the watch, upon looking to the left a horizontal nystagmus will be developed which will persist for about twenty-five to thirty seconds.

The physiologic reasons for this nystagmus cannot be entered into here on account of the lack of space. It is sufficient to say, however, that rotation in one direction with the head erect tests the integrity of the horizontal semicircular canal and ampulla of the opposite side; that is, in rotating the patient to the right we are testing the left labyrinth, and *vice versâ*.

[1] Untersuchungen über den vom Vestibular-apparat des Ohres reflektorisch ausgelösten rhythmischen Nystagmus und seine Begleiterscheinungen, Monatsschr. f. Ohrenheilk., 1906, vol. xl.

[2] Verhand, Deut. otologisch. Gesell., 1907, vol. xvi., p. 267.

If the head is inclined forward, so that it is at a right angle to the vertical plane, the superior semicircular canal and its corresponding ampulla is tested in the same manner. In this case, however, the nystagmus is rotatory instead of horizontal, and is best demonstrated by the patient's looking upward and in the direction opposite to the direction of rotation; that is, on rotating the patient to the right the patient would look upward and to the left, and rotatory nystagmus would be elicited. The duration of the nystagmus in testing the superior semicircular canal is ordinarily of slightly longer duration than that elicited in testing the horizontal semicircular canal, for the reason that in ordinary body movements the fluid of the semicircular canals is more or less constantly displaced in the horizontal plane, and, consequently, exaggerated motions in this plane cause relatively less disturbance than in the plane of the superior semicircular canal. Testing the posterior semicircular canals is extremely difficult on account of the position which these canals occupy. It can only be well done by means of a complicated apparatus, in which the patient is placed in the recumbent posture. It is ordinarily sufficient to test the integrity of the superior and horizontal semicircular canals.

The caloric test of Barany depends also upon certain well-known physiologic reactions, and is conducted as follows: If the normal ear is irrigated with hot water, that is, water as hot as can be borne by the patient without discomfort (110–120° F.) for a few seconds, a rotatory nystagmus is developed on looking to the side of the ear irrigated. If, on the other hand, the ear is irrigated with cold water, that is, water in which ice is allowed to melt slowly, a rotatory nystagmus develops when the eyes are turned to the opposite side. The results obtained from this test depend upon fluid currents set up in the superior semicircular canal as the result of temperature changes. These changes enable us, in various cases, to determine the integrity of the static labyrinth, and are of value in diagnosticating the conditions of labyrinthitis and perilabyrinthitis already mentioned.

In cases of perilabyrinthitis, although at the present time the reason is not fully understood, the activity of the labyrinth is not completely destroyed. In only one instance of this condition have I seen the labyrinth fail to respond to the rotation and caloric tests. When, therefore, the patient fails to respond to either one or both of these tests, we are warranted in assuming that the labyrinth is dead. This does not necessarily mean, however, that there is a purulent labyrinthitis, because in one instance I have seen the labyrinth absolutely dead, both to the rotation test and to the caloric test, and yet later it resumed its function. These cases may properly be classified as cases of serous labyrinthitis.

For testing the function of the acoustic labyrinth we depend upon the whispered or spoken voice, the presence or absence of bone conduction, and the perception of high musical tones. With the hearing in one ear perfect, it is difficult to detect impairment of hearing in the diseased ear. An approximate determination of practically loss of function

can, however, be made by comparing the results obtained by testing the diseased ear first with the healthy ear closed, and then with both ears closed. If, for instance, the patient hears a loud whisper at a distance of one foot from the diseased ear, with the sound ear closed, and does not hear the same whisper at all with both ears closed, it is fair to assume that the hearing in the diseased ear is greatly impaired, but not fully lost. If, however, the same whisper were heard a foot from the ear, whether or not the diseased ear were closed, it would be fair to assume that there was absolutely no hearing in the diseased ear. When the labyrinth is involved, the perception of sound through the solid media of the skull is either greatly reduced or abolished, and with a dead labyrinth the tuning-fork, placed upon the healthy mastoid, would be well heard, while, placed upon the diseased mastoid, it would not be heard at all on the diseased side. The perception of upper tones, as tested by the Galton whistle, is also of value. If the upper-tone limit is reduced, we have strong reason to believe that the labyrinth is involved.

Another test which is of importance in certain cases is the so-called "fistula symptom." It is found that if a fistula is present in one of the semicircular canals, if the air in the external auditory meatus is alternately compressed and rarefied, that this difference in air-pressure will cause nystagmus either to one or the other side. The experiment is easily conducted by taking an ordinary Politzer bag, seeing that the tip fits tightly in the external auditory meatus, and then suddenly compressing the bulb. With each compression the patient should be told to look first to the right and then to the left, and the presence of nystagmus should be noted. Similarly, the patient should be told to look upward and outward, and downward and outward, in either direction, as the bulb is alternately compressed and then allowed to fill slowly, thus condensing and rarefying the air in the external auditory canal. If a fistula is present in one of the semicircular canals, nystagmus may be elicited by this experiment. With a perforation of the drum membrane and a history of suppurative otitis media, the appearance of nystagmus, as the result of this experiment, is usually indicative of a fistula in one of the semicircular canals. From physiologic experiments upon animals, and from observations upon the human subject, it is often impossible to tell which particular canal is involved, as the direction of the nystagmus will depend upon the exact location of the fistula in the various canals.

I am not completely convinced that the fistula symptom is an absolutely certain test of fistula, however, as I have seen cases where inflation of the middle ear in which no suppurative condition was present has produced a well-marked nystagmus. The fistula symptom, however, in conjunction with other evidences of labyrinthine involvement is of a certain amount of diagnostic importance.

A point of great importance in differential diagnosis in these cases of labyrinthine involvement is a change in the direction of the nystagmus. In the early stages of labyrinthine involvement the nystagmus is frequently toward the affected side. Later, when the labyrinth is greatly involved, in other words, when the labyrinth becomes dead, the nys-

tagmus is always toward the healthy side. In any case, however, where we have a nystagmus toward the healthy side, and, later, with or without operation, the nystagmus becomes directed toward the diseased side, the surgeon is warranted in assuming that this nystagmus is not due to labyrinthine involvement, but is due to an invasion of intracranial structures, either to a cerebellar abscess or to a purulent collection about the trunk of the auditory nerve. This was very clearly illustrated in a case seen by myself at my clinic, in which, after a radical operation, the nystagmus was directed toward the diseased side. A large sequestrum was removed which consisted of the entire petrous portion of the temporal bone, including the internal auditory meatus. Here the change in the direction of the nystagmus was the only symptom which made us suspect a deeper lesion.

While the above tests may seem too technical to be embodied in a work on general surgery, they are so easily conducted and afford the surgeon so much information that I have deemed it wise to include them in this chapter.

These cases come under the observation of the general surgeon not infrequently, and the above simple experiments are necessary in order to determine the advisability of operative interference. It may be laid down as a general rule, to which there are, however, some exceptions, that an acute otitis is seldom followed by an acute labyrinthitis demanding surgical interference. True, we find in certain cases of acute otitis and acute mastoiditis cases showing disturbances of equilibrium, sometimes showing nystagmus toward the diseased or sound side. When such symptoms appear in a case of acute involvement of the middle ear or mastoid, they are usually due to one of two causes, either to an inflammation of the perilabyrinthine structures which, through the medium of the circulation, has caused certain disturbances of pressure in the endolymph, or to a serous labyrinthitis; that is, an actual effusion of serum into the vestibule and semicircular canals, which has temporarily interfered with the motility of the fluid in these channels.

In a case of acute inflammation of the middle ear and mastoid, while the symptoms of vertigo, nystagmus, nausea, and vomiting, and profound disturbance of hearing should make the surgeon on the alert as to the possibility of an acute labyrinthitis, such a diagnosis should not be made unless the labyrinth fails to respond either to the caloric or rotation test. It is much better in these acute cases to relieve the suppuration in the middle ear and mastoid by the ordinary mastoid operation. The only exception which I would make would be a case in which the labyrinthine symptoms were very pronounced and a considerable elevation of temperature was present. In such an event, exploration of the labyrinth might be justifiable if the caloric and rotation tests showed the labyrinth to be dead. In every other instance, however, I should rely upon the simple mastoid operation as the primary procedure, inspecting carefully, of course, at the time of this operation the horizontal semicircular canal to determine the possibility of a localized lesion in this region. The presence, however, of a circumscribed erosion over

the horizontal semicircular canal, in the absence of symptoms indicating a dead labyrinth, would not warrant the surgeon in opening the labyrinth at the primary operation. We know that numerous cases of circumscribed labyrinthitis occur, and that these cases will clear up perfectly upon the removal of the focus of infection. The complete mastoid operation, however, is the first step to be performed, excepting in those cases attended by very severe constitutional symptoms, elevation of temperature, and reactions showing a dead labyrinth.

In cases of chronic suppurative otitis media the decision as to whether or not to open the labyrinth at the time of the primary operation is more difficult. It may be laid down as a general rule, however, that unless the hearing is absolutely destroyed upon the affected side, and the labyrinth fails to respond to the caloric and rotation tests, even the presence of moderate labyrinthine symptoms, such as a disturbance of equilibrium and vertigo, the labyrinth is not to be interfered with at the time of the primary operation. The mere presence of a nystagmus toward the sound side, indicating, of course, a dead labyrinth, is not in itself a sufficient indication for draining this structure. At the time of operation on some of these cases, we find a localized erosion of one of the semicircular canals, usually of the horizontal semicircular canal at its convexity. Such an erosion may represent a circumscribed labyrinthitis, and should be treated by a simple curetment of the diseased area. Total ablation of the labyrinth is not necessary in a case of this kind—certainly not as a primary procedure. I have seen a number of cases in which such an erosion has been found, and which have been treated simply by curetment of the diseased area, and in one case by enlarging the opening, so as to drain the vestibule posteriorly. All of these cases have made a complete recovery.

Regarding cases where at the time of operation, especially for chronic suppurative otitis media, the foot-plate of the stapes is found to be absent and granulations protrude from the oval window, the plan of procedure advisable can be much less dogmatically stated. The presence of granulation tissue about the oval window is always a sign of extreme significance, and, if the probe enters the vestibule, would seem to indicate that a true suppurative labyrinthitis existed. I have seen at least one case, however, in which the removal of these granulations without drainage of the vestibule resulted in a perfect cure. This was undoubtedly a case of circumscribed labyrinthitis limited to the vestibule. In this patient no labyrinthine symptoms had been present. Whether or not, therefore, in a case of *chronic* middle-ear suppuration the surgeon shall drain the labyrinth at the time of the radical operation will depend, first, upon the presence and severity of symptoms referable to the static labyrinth; second, the condition of the hearing labyrinth; and, third, the constitutional disturbance as indicated by elevation of the temperature. In some cases of chronic suppurative otitis media we may have symptoms of acute invasion of the labyrinth, such as profound deafness and severe vertigo. Increased temperature, however, may be wanting, and the hearing, although very profoundly impaired, may not be completely

destroyed, while the function of the static labyrinth, as determined by rotation, remains perfectly normal. In such a case the surgeon has to deal with a perilabyrinthitis, and a complete radical operation is all that is necessary to relieve the condition. In a similar case, where the rotation and caloric tests showed a dead labyrinth, the surgical procedure would naturally consist in total ablation of the labyrinth.

It is important to differentiate between these cases of labyrinthitis and perilabyrinthitis prior to operation, as by failing to do this we practically destroy the hearing of an ear which might otherwise be in part conserved. This is, of course, of great importance where the patient is suffering from a double lesion, in which the hearing of one ear is absolutely destroyed, and the ear in question is the only organ of hearing which the patient has.

The character of the operative interference in a case of suppurative labyrinthitis will depend upon whether symptoms of meningitis are present. If we have to deal with a case of simple suppurative labyrinthitis, that is, a dead labyrinth, without elevation of temperature, the simplest operation for the drainage of the labyrinth consists in entering the vestibule through the prominence of the horizontal semicircular canal.

A radical operation must always be done as a preliminary step in order to expose the parts sufficiently, and the usual meatal flap, recommended in the description of the radical operation, is formed at the completion of the operation. After the radical cavity has been prepared the operation may be proceeded with as follows: The horizontal semicircular canal is opened along its greatest convexity, and this opening is gradually enlarged downward and backward until the probe freely enters the vestibule. The surgeon should constantly bear in mind that the facial nerve lies immediately below the horizontal semicircular canal, and, consequently, that the bone may be removed along the superior aspect of the canal with comparative impunity. As soon as the lower wall of the canal is interfered with, however, the facial is endangered. The canal is best opened by means of a small gouge. As soon as the lumen of the canal is opened a fine probe is passed in the direction of the vestibule, and the opening cautiously enlarged downward, backward, and inward until the ordinary surgical probe can be passed into the vestibule. The next step is to open the cochlea. This is best done by removing the small bridge of bone between the oval and round windows. A single stroke of the gouge will remove the outer wall of the first and part of the second turn of the cochlea. The probe introduced into the horizontal semicircular canal can now be passed downward and forward and then abruptly outward beneath the facial ridge, making its exit in the middle ear at a point where the internal wall of the tympanum was removed. The complete operation is well shown in Fig. 327.

Naturally, skin-grafts cannot be applied to the radical cavity if the labyrinth has been opened. It is necessary to pack both the cochlear and semicircular canal openings with iodoform gauze and also to pack lightly the middle-ear cavity. The posterior wound is sutured in the

same way as after the radical operation. At the end of ten days, if no further symptoms follow, the surgeon may apply a skin-graft to the radical cavity, in the manner already suggested in describing the radical operation, or the entire middle-ear cavity may be allowed to dermatize from without inward. Considerable time will be saved, however, by application of the Thiersch graft.

In cases where severe constitutional symptoms are present as the result of the labyrinthine infection, in other words, where a beginning meningitis is either present or suspected, I am in favor of opening the

FIG. 327.—OPERATION FOR SUPPURATIVE INFLAMMATION OF THE LABYRINTH. (Dench.)
This figure shows the complete radical operation, with ablation of the posterior, horizontal, and superior semicircular canals, with drainage of the vestibule posteriorly. The oval window has also been enlarged downward and forward, so as to drain the vestibule anteriorly. The curved sound is passed through the enlarged oval window upward and backward into the vestibule, passing beneath the bridge of bone which lodges the facial nerve. (Author's dissection.)

labyrinth according to the manner of Neumann. In this operative procedure, after the radical operation has been performed, the lateral sinus is exposed in the posterior portion of the wound, and the dura in the middle cranial fossa is also exposed. We have then presented a triangular space, the boundary of this triangular space being as follows: dura of middle cranial fossa above, lateral sinus behind, and facial ridge below. By means of a grooved director the dura is gradually separated anteriorly from the overlying bone, and a protector of some sort, either a blunt dissector or, preferably, the blade of a moderate-sized curet, is introduced between the dura and the bone lying between the sinus

and the facial edge. The bone is then gradually removed, in the forward direction, by means of vertical cuts of the gouge, the protector preventing injury of the dura. As the surgeon works forward two openings will come into view. These represent a section of the posterior semicircular canal. Continuing the separation of the dura still further forward and still removing the bone, two openings in the bone will be found in close apposition. These represent the *crus communis* of the superior and posterior canals and the cross-section of the horizontal semicircular canal. A delicate probe is now passed into the upper of

FIG. 328.—OPERATION FOR OPENING THE VESTIBULE ACCORDING TO THE NEUMANN METHOD, MODIFIED BY THE AUTHOR.

The auricle is seen drawn forward and the customary auricular flap stitched in position: *a*, Represents dura exposed over middle fossa; *b*, lateral sinus exposed. Note that the dura in front of sinus is exposed for a considerable distance. The probe is seen in position entering the vestibule posteriorly and passing beneath the facial ridge, forward and outward, through the opening made by opening the first and second turns of the cochlea. (Author's dissection.)

these openings and made to enter the vestibule. According as the probe passes upward or downward, the gouge is applied in the upward or downward direction, so as to thoroughly enlarge the opening into the vestibule. This drains the vestibule posteriorly. The cochlea is then drained in a manner precisely similar to that described in entering the vestibule through the horizontal semicircular canal.

If symptoms of meningitis are present, after the vestibule has been entered the dura is separated from the bone still further inward, and more bone removed, passing beneath the facial ridge, until the operator reaches the sheath of the auditory nerve. According to the investigations of

Neumann a meningitis secondary to labyrinthine involvement most usually attacks the subtentorial space, along the trunk of the auditory nerve. If bone is removed down to the auditory nerve-trunk and the dura freely incised in this region, the subdural space is thoroughly drained, and in a certain number of cases satisfactory results have been obtained in cases of meningitis. While the operation has never been successful in my hands, it is worthy of trial. Aside from the drainage of the labyrinth, it is the same method suggested by myself[1] in the drainage of the subdural space in cases of otitic meningitis.

Division of the Auditory Nerve for Persistent Tinnitus Aurium or for Persistent Otalgia.—While tinnitus aurium is ordinarily controlled by local treatment of the middle ear or by constitutional treatment directed toward the perceptive apparatus, certain cases of very severe tinnitus are occasionally met with in which this symptom causes such severe mental symptoms as to be an actual menace to life. Some of these patients threaten suicide, while in others the neurasthenic condition following the continued subjective noise in the ear is so severe as to warrant the surgeon in instituting radical measures for the relief of this condition. It should be clearly borne in mind that section of the auditory nerve is a grave operation, endangering the life of the patient, menacing the integrity of the facial nerve, and always leading to complete deafness. It is an operation which should be recommended only as a last resort and only in the most severe cases. Where the operation is performed for the relief of persistent tinnitus the integrity of the facial nerve is not necessarily interfered with, although it is frequently impossible to divide the auditory trunk without interfering with the facial, and the patient should always be warned against the possibility of a facial paralysis.

When a division of the auditory, the nerve of Wrisberg, and the facial is undertaken in cases of persistent neuritis of the seventh and eighth nerves, with their communicating branch, namely, the nerve of Wrisberg, facial paralysis always follows.

The symptomatology of these cases of persistent otalgia has been well described in monographs by J. Ramsay Hunt.[2] Briefly speaking, these cases of otherwise unexplainable otalgia are due to a neuritis of the seventh and eighth nerves, and in the most persistent cases they are relieved only by surgical interference. Comparatively few successful cases of surgical interference, either of persistent tinnitus or of persistent otalgia, are on record.

In one case recently operated upon by myself the result was perfect. The tinnitus completely disappeared and no facial paralysis followed. The steps of the operation are as follows: An incision is made from the spine of the second cervical vertebra vertically upward, and just beyond the median line toward the healthy side, until the incision passes just

[1] The Treatment of Acute Otitic Meningitis, read before the Eighth International Otological Congress, Budapest, 1909.

[2] Jour. Nerv. and Ment. Dis., Feb., 1907; Archiv. of Otol., 1907, vol. xxxvi., No. 4; Jour. Nerv. and Ment. Dis., June, 1909, vol. xxxvi., No. 6.

above the level of the occipital protuberance. The incision is then continued horizontally outward toward the affected side to a point which corresponds to a vertical line drawn through the point of emergence of the mastoid emissary vein. From this point the incision is carried vertically downward to below the tip of the mastoid. The incision passes first through the integument and the tegumentary flap should be dissected up. This dissection should be made rapidly, and all bleeding points quickly caught with hemostatic forceps. Considerable hemorrhage follows the incision, and it is well that firm pressure be made along the line of incision, either by the fingers of the surgeon or by those of the assistant, in order to reduce the loss of blood as much as possible. After the skin-flap has been dissected free, the fascia, muscles, and periosteum are reflected downward in a single flap, the hemorrhage being quickly controlled, as in the separation of the cutaneous flap. While it is sometimes possible to escape the mastoid emissary vein, I have found in the cases operated upon that this vein is usually divided close to the mastoid foramen. Hemorrhage is best checked in this region by plugging the mastoid foramen with plugs of sterile orange-wood. The ordinary orange-wood sticks, used as nail cleaners, if thoroughly boiled, answer admirably for this purpose. After the soft parts have been separated from the bone throughout the entire extent of the incision the bone covering the cerebellum is completely removed over the entire extent of the flap. I do not make an osteoplastic flap in cases of this kind, although the osteoplastic method has been used by Taylor and others. The soft tissues are so thick in this region and afford such a perfect protection to the exposed brain that the osteoplastic flap seems unnecessary to me. The bone is best removed by first opening the cranial cavity just below the superior curved line of the occipital bone, where the bone is exceedingly thin. A single cut with the large gouge exposes the cerebellar dura. After this the bone can be quite rapidly removed in all directions by means of the rongeur forceps. After the dura has been exposed and before introducing the rongeur it is well to separate the dura from the underlying bone, either by means of the blunt dissector or a grooved director. In this manner the bone should be removed to a point just beyond the occipital sinuses in the median line, above, to a line exposing the lateral sinus, and anteriorly, along the line of the sigmoid sinus. The lateral sinus and its extension, the sigmoid sinus, are so firmly attached to the walls of their respective grooves that considerable force is necessary in order to separate these sinuses, consequently, the resistance which the operator meets with indicates that the lateral sinus and the sigmoid sinus have been encountered. The removal of bone is continued along the line of the lateral and sigmoid sinuses, and then downward to the margin of the foramen magnum. I have not found it necessary, in the cases operated upon, to encroach upon the foramen magnum, although many operators break freely into this opening, and no unfavorable result follows. After the dura has been freely exposed in this manner, all hemorrhage must be completely checked, after which the soft parts are sutured into position, layer by layer. Ordinarily cat-

gut sutures are used for the muscular flap and silkworm-gut for the cutaneous flap. An ordinary antiseptic dressing is applied and the patient is returned to bed.

This is the first step of the operation. This primary operation is ordinarily followed by no serious reaction, and at the end of a week the second stage of the operation may be performed. This consists in reopening the wound and reflecting downward a large dural flap, the margins of which lie just within the boundaries of the occipital, lateral, and sigmoid sinuses, the base of the flap being downward. It is important to recognize vessels running through the dural flap, and vessels of any size should be divided between two ligatures, the ligatures being applied by passing a flat curved needle, armed either with the delicate catgut or with very fine silk, beneath these vessels, the ligature being tied before the flap is cut.

Hemorrhage from the cerebellar vessels should be carefully guarded against, as hemorrhage may completely defeat the object of the procedure. Any oozing is best controlled by applying small bits of sterile cotton to the bleeding points. If the vessels are large, they may be ligated either with very fine silk or fine catgut, preferably the former. Of course, there will be a certain amount of oozing from small vessels which cannot be ligated. This oozing is best controlled by the application of adrenalin chlorid. I am inclined to think that considerable space may be gained by the application of adrenalin chlorid to the exposed cerebellar substance, owing to the contraction of the small vessels which this drug causes. Adrenalin chlorid also raises the blood-pressure and, to some extent, counteracts the shock which follows the evacuation of the fluid from the subtentorial space.

After the dural flap has been reflected downward the next step in the operation is the exposure of the trunks of the auditory and facial nerves. A thin retractor of flexible metal, either copper or silver, is introduced between the cerebellum and the underlying bone, and the cerebellar hemisphere is raised upward and, at the same time, crowded toward the median line. This retraction of the cerebellum must be made very slowly and conducted under good illumination, the illumination being secured either by means of the head-lamp or with the head-mirror and reflected light. As the cerebellum is elevated the subtentorial lymph-sac is opened and there is a free gush of cerebrospinal fluid. This fluid must be carefully mopped away by means of gauze sponges, and the retractor, hugging the floor of the cerebellar fossa, must be gradually introduced toward the median line until the cerebellum is sufficiently displaced inward, and drawn upward and outward to expose the internal auditory meatus and the trunks of the facial and auditory nerves entering this opening. Ballance has advised the use of ordinary marine sponges which, by their absorption of moisture and consequent increase in volume, mechanically crowd the cerebellum toward the median line. I have used marine sponges in one case, but did not find them efficient, and was obliged to depend upon the ordinary brain retractor in order

sufficiently to expose the operative field. The exposed field is well shown in Fig. 329.

After the facial and auditory nerve-trunks are in full view, the next procedure depends upon whether the operator desires to divide the audi-

FIG. 329.—EXPOSURE OF THE SEVENTH AND EIGHTH NERVES FOR DIVISION OF THE EIGHTH NERVE IN CASES OF UNCONTROLLABLE TINNITUS.

The cerebellum is lifted upward and inward by means of the retractor. The reflected dural flap is well shown. *a*, Common trunk of facial and auditory nerves. The lower portion of the divided trunk represents the auditory nerve, and this is to be alone divided in cases of persistent tinnitus. In cases of severe otalgia the facial and auditory are both to be divided, together with the nerve of Wrisberg. The nerve of Wrisberg is not shown in the illustration, but cannot escape division if both the auditory and facial are severed. The illustration also shows the sixth nerve in front of the combined auditory, the facial trunk, and the lateral sinus, close to the margin of the dural incision. (Original dissection by the author.)

tory alone or whether he wishes to sacrifice both the auditory and the facial nerve-trunks. In cases of tinnitus it is sufficient to divide the auditory nerve-trunk alone, and every effort should be made to preserve the integrity of the facial nerve. For this purpose it is well to have at

hand a faradic battery equipped with one long slender electrode, which can be thoroughly sterilized and introduced into the cranial cavity. The opposite electrode should be a flat sponge, applied to some neutral point. By means of faradic stimulation the facial trunk is easily recognized. The facial trunk lies above the auditory nerve-trunk, and the auditory artery can ordinarily be seen running between these two nerve-trunks. If the operation is performed for tinnitus, the auditory nerve is drawn downward by means of the grooved director until it is torn asunder. The inner extremity is then grasped by the forceps and pulled out from its central attachment.

If the operation is performed for persistent otalgia, it is necessary to divide both the facial and auditory nerve-trunks and the nerve of Wrisberg. This, of course, is the simpler operation, as no effort is made to preserve the integrity of the facial. In cases where the operation is performed for tinnitus alone, after the division of the auditory trunk it is well to apply faradic stimulation to the facial nerve, so as to demonstrate its integrity before the completion of the operation. After one or both nerve-trunks have been divided the dural flap is sutured in place by means of very fine sterilized silk. The muscular flap is sutured with catgut sutures and the cutaneous flap held in position by silkworm-gut sutures. In the one case operated upon by myself the procedure was completely successful.

CHAPTER CXXXVIII.

SURGERY OF THE EYE.[1]

By George E. de Schweinitz, M. D.,
Philadelphia.

Additional Method of Extracting Cataract.—A brief reference to the operation for the extraction of cataract designed by Colonel Henry Smith, of Armritzar, India, appears in my former chapter on the Surgery of the Eye (Vol. IV., p. 849), but as this operation has attracted much attention in recent years, a more extended description than it received in the previous volume is here recorded.

Colonel Smith's Operation for the Extraction of Cataract (*Indian Method for the Extraction of Cataract in the Capsule; Radical Operation for Cataract*—Vail).—Colonel Smith anesthetizes his patient's eye by the instillation of 2 drops of a 5 per cent. solution of cocain, five minutes apart, and the whole conjunctival culdesac, after the eyelids are washed with soap and hot water, is thoroughly flushed with a solution of bichlorid of mercury (1: 2000). This vigorous application of bichlorid seems necessary in the Indian patients in Colonel Smith's service, as their conjunctivæ are frequently the seat of various infected lesions, notably trachoma. This solution is much stronger than it is the custom of surgeons in this country to employ, and is probably unnecessary except under the circumstances detailed. The instruments used, in addition to a narrow Graefe cataract knife, are depicted in Fig. 330.

In "A System of Ophthalmic Operations," edited by Casey A. Wood, M. D., D. W. Greene, of Dayton, Ohio, quotes Colonel Smith's description of his method of extracting cataract. The paragraphs which follow, considerably condensed and slightly modified, have been taken from this description. The illustrations are by Derrick Vail, and are utilized with his kind permission.

After a spring speculum has been inserted, the eye being fixed with special forceps, a Graefe knife is entered at the corneoscleral junction and counterpuncture made in the corneoscleral junction of the opposite side, so that the incision when completed shall include half or nearly half of the circumference of the cornea. The knife is driven through to the heel, the handle being lowered as it passes onward and the point elevated. If the manipulation is a proper one, after the counterpuncture is made the knife cuts as it goes through the tissues, and the incision is completed with one thrust, the incision ending in the cornea in such a manner that the edges of the corneal wound are cut as nearly as possible at right angles to the surface. An iridectomy may or may not be done, but it is advisable, for the beginner at least, to make this part of the operative procedure.

[1] Supplementary to Chapter LXV., Vol. IV., p. 849.

The speculum is now removed, and the eyelid and brow are held as is indicated in Fig. 331. In the case of an immature lens or of a hard cataract the operator next presses back with the point of a strabismus hook toward the optic nerve, the point of the hook being placed over the lower third of the cornea. This pressure must be steady, and the point of the hook should not be removed until the upper edge of the lens tilts forward. The moment the lens is seen to be dislocated, the pressure through the point of the hook is gradually turned more and more toward the wound, pressure

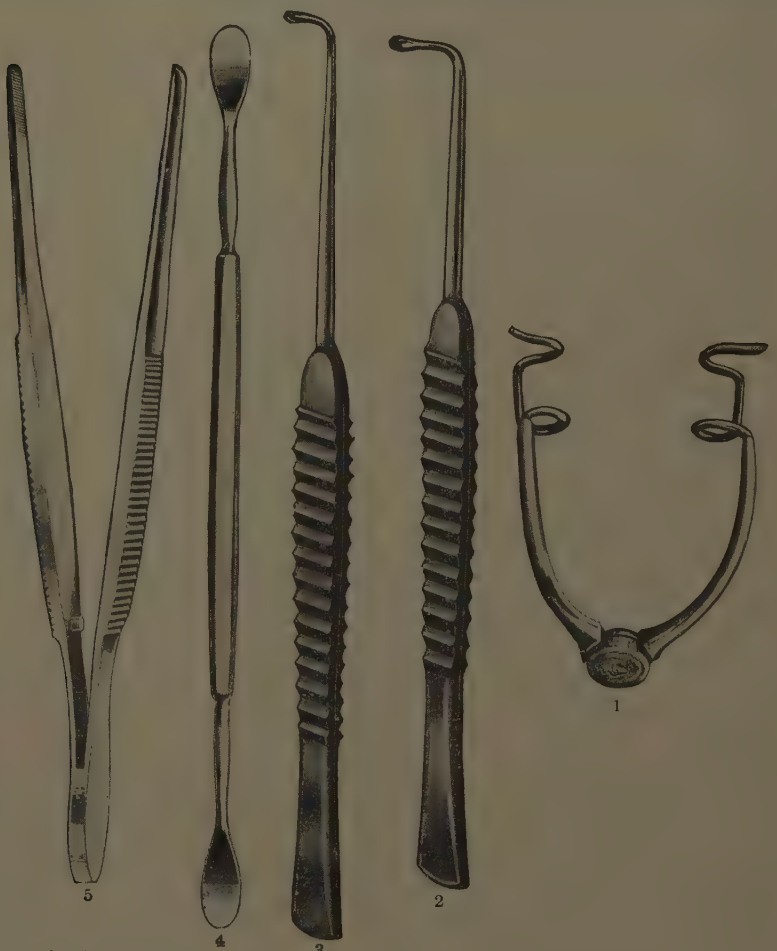


FIG. 330.—INSTRUMENTS EMPLOYED BY SMITH IN HIS OPERATION FOR INTRACAPSULAR EXTRACTION. (D. W. Greene.)

1, Speculum; 2, lid hook; 3, expression (delivery) hook; 4, double-ended spatula; 5, broad forceps for extraction of ruptured capsule.

during all of this time being maintained, so as to keep the lens up to the sclerotic margin, the pressure with the hook becoming gradually lighter and lighter and the hook gradually sliding under the lens until the cornea is folded beneath it. At this stage the lens is delivered (Fig. 332).

If the tension of the eye is low, the emerging lens should be followed with a spatula as well as with a hook, and sometimes, under these circumstances, a light counterpressure with a spatula above the wound is indicated.

In the case of intumescent lenses and Morgagnian cataract, the capsules of which

are extremely delicate and liable to burst, pressure with the point of the strabismus hook is made sufficiently deep over the lower border of the lens to cause it to dislocate below and turn a half somersault, the pressure and traction always being made over the zonula. As soon as the lens turns up into the wound the operator ceases to make traction toward the patient's feet and directs the pressure backward, next backward and upward, and finally more and more toward the wound, folding the cornea beneath the lens until it falls outside of the cornea. As the capsule has not yet been dislocated from the zonula in the neighborhood of the wound, the hollow of the curve of the strabismus hook should now be made to sweep along between the lens and the wound to complete this detachment. It is advisable under these circumstances to keep up sufficient tension on the eyeball with the spatula placed on the cornea in order to prevent the lens from slipping back into the eye.

Hypermature cataract is difficult to dislocate, and the operator should proceed with the strabismus hook as in the case of immature and hard cataract, but a spatula in his left hand should be in position at the margin of the wound to drop behind the lens the instant its edge appears. As it is dropped almost straight down into the eye, the back of the spatula must be placed against the sclerotic margin of the wound and the lens pressed against it with the hook from the outside. The lens, therefore, slides along the inclined plane of the spatula.

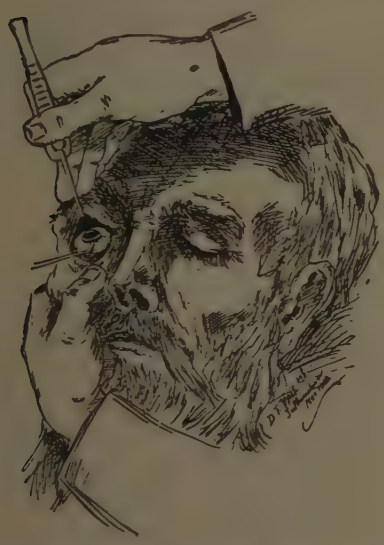


FIG. 331.—SMITH OPERATION FOR CATARACT. (Vail.)

Shows how things look from in front (spectator's view), while the lids are being held by the assistant and the hook for expelling the lens is applied. Notice the gable-like space under the upper lid above the eyeball. The operator may look obliquely under the upper lid in this field and get a good exposure of the entire upper *cul-desac*. The assistant can shift this exposure to the right or left to enable the operator to have an unobstructed view of the lens and wound; also to give him access to the angles of the wound and the summit too when replacing the cut sides of the iris, and the apron of the iris that adheres to the scleral wound after delivery.

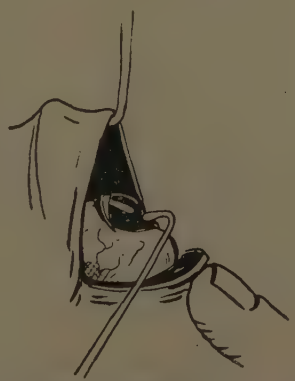


FIG. 332.—SMITH OPERATION FOR CATARACT. (Vail.)

Shows where the bulbous end of the lens hook is applied in the act of pressing to expel the lens. The pressure is made "straight back toward the optic nerve" without a moment's hesitation or dallying, not quickly or plungingly, but with intelligent and bold onward pressure, never varying the direction of the pressure until you see one of two things, either the lens break its moorings above or below and show a disposition to be born, in which case you favor the exit by shifting the pressure, or the lens stubbornly refuse to yield and advance because of tough ligaments, small size of the incision, or what not.

Great care should be taken to return the iris to its proper position, whether or not an iridectomy has been made, and with a suitable repositor the operator should release any part of the iris from the sclerotic or from the angles of the wound. If this is carefully done the eye need not be dressed until the expiration of the eighth day, and many of the complications which have been described may be attributed to meddlesome dressings and meddlesome inspections. If vitreous escapes, it should be snipped off with the scissors in the usual manner.

On the following pages the various steps of the operation are illustrated with Vail's drawings and his descriptions.

According to Colonel Smith, cataracts occurring in children and young persons are not suited to this operation, because it is practically

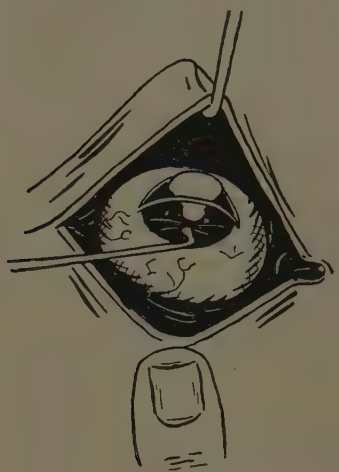


FIG. 333.—SMITH OPERATION FOR CATARACT. (Vail.)

Showing front view of the same. The lens is coming up nicely and the equator will soon pass the incision. The pressure is still deep, but about to be shifted upward to drive the lens out and keep all gaps between lens and incision closed. The operator is standing to the *patient's right with his head low toward the patient's chest*, so that he can see exactly what he is doing. The view he gets is about as shown in this figure.

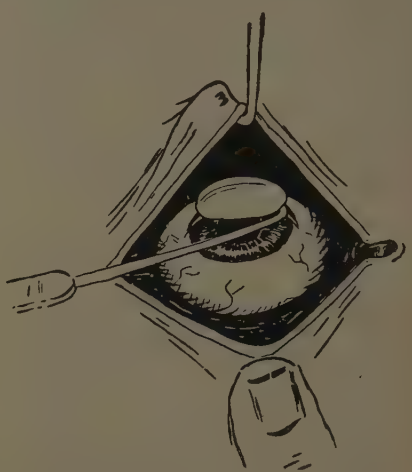


FIG. 334.—SMITH OPERATION FOR CATARACT. (Vail.)

The lens lies outside the eyeball. The cornea has been tucked behind it and the operator is removing it from its last moorings, at the same time "ironing" the incision in good approximation by using the hook like a golf club (mid-iron) is used to rake a golf ball from a pond into which it has fallen, not forcibly, but coaxingly and gently, yet making good progress, being careful that the tip of the hook is not caught in the wound. To guard against this the elbow of the hook must depress the lips of the wound under the lens, while the bulbous end is directed nearly vertically away from the incision.

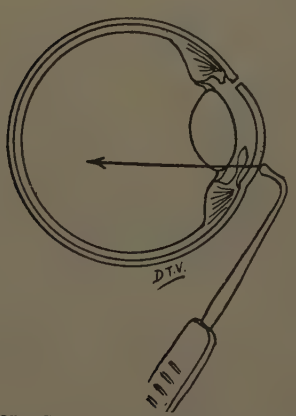


FIG. 335.—SMITH OPERATION FOR CATARACT. (Vail.)

Shows first position of the lens hook as applied to the eyeball after section and iridectomy. Note direction of pressure as indicated by the arrow in each of these.

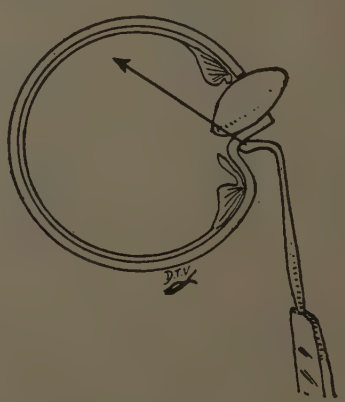
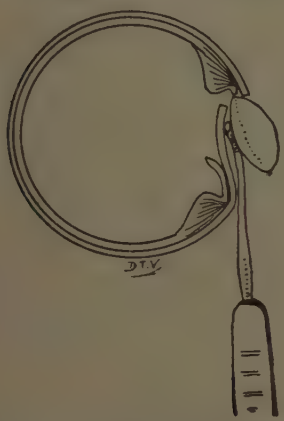


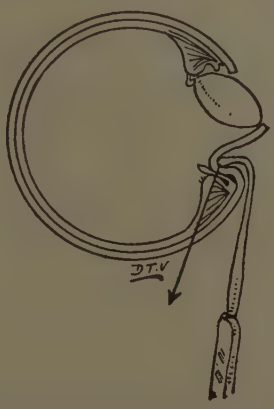
FIG. 336.—SMITH OPERATION FOR CATARACT. (Vail.)

Shows lens about to be delivered upright. The cornea is being tucked behind the lens as lens advances from the eye.

impossible to dislocate their lenses. The operation seems to be valuable in unripe cataract, and in those forms of cataract which are

immature and which require long periods of time for their complete opacification. Much difference of opinion exists as to the value of this operation and its permanent place in surgical practice. In our





FIGS. 337, 338.—SMITH OPERATION FOR CATARACT. (Vail.)
The lens is torn and the cornea is properly tucked under it to prevent its settling back in the eye.

own country the operation has been particularly recommended by D. W. Greene and Derrick T. Vail, who had large opportunities of learning the technic in Colonel Smith's clinic in India, and Vail, in particular,

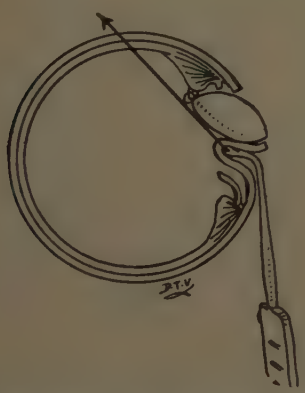


FIG. 339.—SMITH OPERATION FOR CATARACT. (Vail.)

As the lens advances after it has severed its lower ligamentous attachments and is turning, the pressure is shifted to follow it up, and is now no longer toward the patient's feet, but toward the top of the head, to keep all cracks and gaps between lens and wound closed to prevent vitreous escape. If traction is kept up too long no advance of the lens will take place, but you will see a vitreous presentation as illustrated in each of the next two figures.

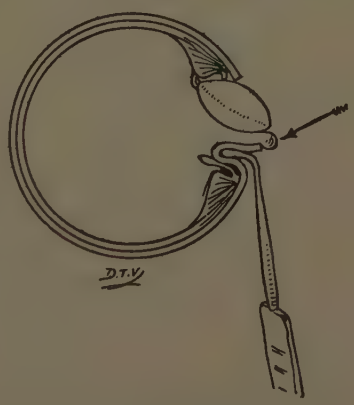


FIG. 340.—SMITH OPERATION FOR CABATACT. (Vail.)

The cornea should have never been permitted to leave its hugging approximation to the lens. The pressure was continued toward the patient's feet too long.

has written a monograph on the subject which contains the fullest information, and is illustrated with a series of original drawings, some of which are reproduced with his permission.

One of the usually stated objections to the Indian operation is that the percentage of loss of vitreous is much higher than in the ordinary extractions of cataract. Colonel Smith has reported his percentage of

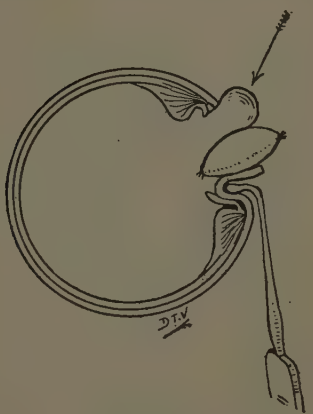


FIG. 341.—SMITH OPERATION FOR CATARACT. (Vail.)

Sometimes the vitreous will present above; in fact, will do so in the majority of these cases where the pressure is not intelligently made with the hook below. This and the last illustration show the result of clumsy operating and lack of skill.

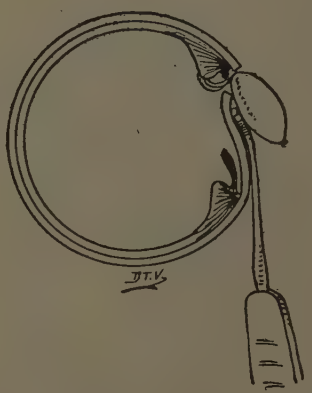


FIG. 342.—SMITH OPERATION FOR CATARACT. (Vail.)

Shows the cornea tucked under and behind the lens that has been successfully delivered by turning.

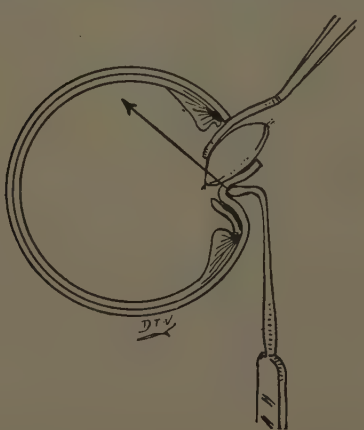


FIG. 343.—SMITH OPERATION FOR CATARACT. (Vail.)

The vitreous has only "presented." The spoon is not introduced far into the vitreous, but only just behind the upper rim of the lens and slightly within the vitreous chamber. The pressure with the lens hook against the cornea has been held in abeyance during the introduction of the spoon, but after the spoon is in place the pressure now follows the lens and drives it out of the eye against the spoon, as a stationary inclined plane.

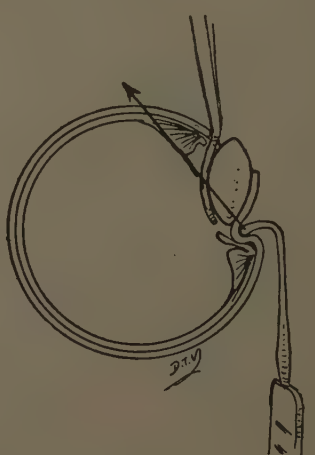


FIG. 344.—SMITH OPERATION FOR CATARACT. (Vail.)

If there has been actual loss of vitreous and more coming, the spoon is dropped down behind the lens until it is deep in the vitreous and just back of the lens. The spoon is now held fixedly and the lens expelled by pressure through the cornea by means of the lens hook. Thus at no time is the spoon ever used to rake the lens out of the eye.

vitreous loss to be 8 per cent., while Vail, in a series of uncomplicated cataracts, did not exceed 2 per cent. of vitreous loss, and therefore he believes, to use his own expression, that vitreous escape is not the ar-

gument to be used against Smith's technic. Naturally, the ordinary accidents of cataract extraction are liable to occur, but apparently in Smith's Indian service they are not greater than those which occur in ordinary extraction, and certainly the dangers of iritis and the complications from retained capsule are much less frequent. It is doubtful whether this operation will ever replace the earlier and older methods of cataract extraction, and it is my own impression, based on a very limited experience and upon the observations of operators who are familiar with the Smith technic, that while it has a place in ophthalmic surgery, especially in the extraction of unripe cataracts, it is not an operation that is liable to drive from the field those procedures which have for years been firmly and favorably established.

The Newer Operations for Glaucoma.—To replace iridectomy, which for half a century, since its introduction by Von Graefe, has been the classical operative procedure for the relief of increased intra-ocular tension, especially in acute glaucoma (and in this disease it continues to be the most satisfactory operation), a number of operative procedures have been devised. They are of especial value in chronic forms of glaucoma because there is abundant evidence that simple iridectomy in this affection is only too frequently futile.

Cyclodialysis (Heine's Operation).—This operation was suggested by Heine in 1905, and with it an endeavor is made to form an artificial communication between the anterior chamber and the suprachoroidal space. Now, while there is no positive proof that after its performance drainage really occurs into this space, it is possible that a successful cyclodialysis reopens the angle and brings it again into communication with Schlemm's canal. The operation is performed as follows:

> "After the reflection of a small conjunctival flap, preferably on the outer side of the eyeball, an opening is made into the sclera with a straight lance, parallel to the corneal margin and from 6 to 8 mm. away from it, without injuring the uveal tissue. This opening should be from 2 to 3 mm. in length, and through it a spatula is introduced with which the ciliary body is separated from the overlying sclera, and the instrument gradually pushed through the ligamentum pectinatum into the anterior chamber. Finally, a quadrant of the iris periphery is detached. Occasionally some difficulty is experienced in passing the spatula between the ciliary body and the sclera into the anterior chamber, and in a few instances hemorrhage into this chamber has occurred" (Figs. 345 and 346).

After this operation reduction of tension may not be noticeable until the following day, but if successful, the increased intra-ocular tension should disappear by the second or (at latest) by the third day, and if tension remains low for a week, the ultimate result is likely to be good. The operation has proved to be satisfactory in secondary glaucoma due to anterior synechia or subluxation of the lens, in glaucoma following cataract extraction, in advanced cases of chronic glaucoma where iridectomy has failed, and in absolute glaucoma. It is not an operation which is likely to replace iridectomy. I have performed cyclodialysis chiefly for the relief of the advanced types of glaucoma already described, but it is not an operation which should be performed for the relief of chronic glaucoma of the ordinary type and of acute glaucoma.

Much attention has been paid in recent times to the formation of a "*filtering cicatrix*," a term coined by De Wecker many years ago, be-

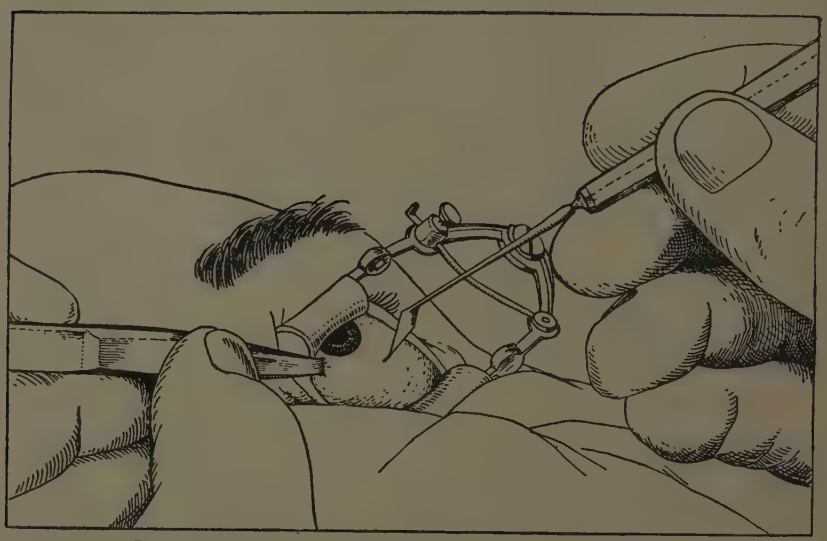


FIG. 345.—HEINE'S OPERATION FOR GLAUCOMA. (After Meller.)

Cyclodialysis in the left eye. The eyelids in this operation are held apart by a spring speculum. After the conjunctiva has been incised and the sclera exposed to view, a short incision is made with the lancet (keratome) parallel to the limbus and at a distance of about 5 mm. to the outer and lower side of it. The lancet is made to cut with its side and not with its point.

cause he, Von Graefe, and many of the earlier writers were quite familiar with the value of a cicatrix of this character, in that it secured more

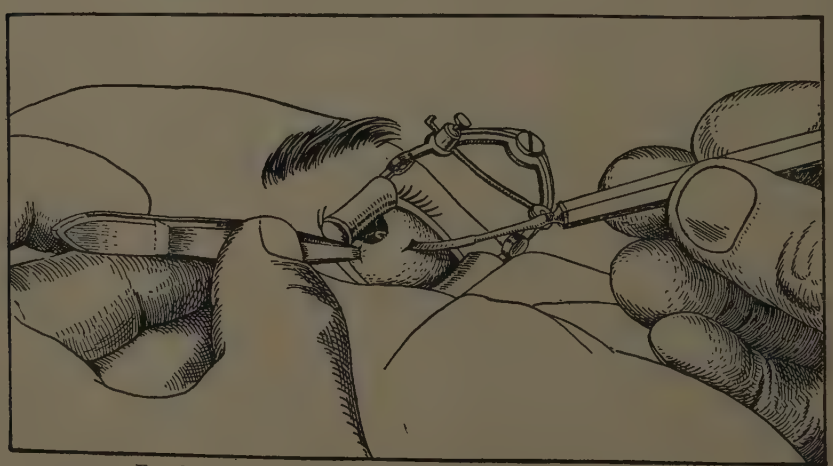


FIG. 346.—HEINE'S OPERATION FOR GLAUCOMA. (After Meller.)

Cyclodialysis. The spatula, held parallel with the surface of the sclera and the ciliary body, appears in the angle of the chamber.

effectually than a smoothly healed section a state of reduced intra-ocular tension. Such a scar, however, is a source of danger because it may be

the pathway of infection, particularly if the iris has been incarcerated in the wound.

To obviate this danger, and at the same time to produce a filtering cicatrix, Lagrange has designed the following operation:

Combined Iridectomy and Sclerectomy (Lagrange's Operation).—The operation is performed as follows:

"The sclera is punctured at a distance of 1 mm. from the limbus, and the counter-puncture is made at a corresponding point. The sclera is divided in the iridocorneal

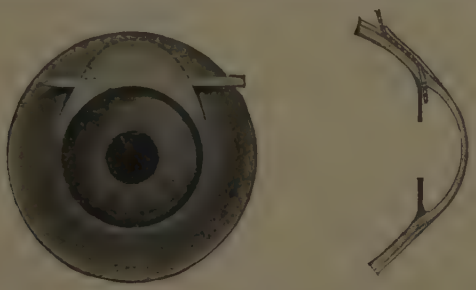


FIG. 347.—LAGRANGE'S OPERATION.
Section of the sclera and conjunctiva.

angle. In terminating the incision the cutting edge of the blade is directed backward in such a way as to bevel the sclera, and when the knife is beneath the conjunctiva a large conjunctival flap is made. In the second stage of the operation the conjunctival flap is raised, but not cut in any way, and a sufficiently large piece of the sclera is resected from the exterior lip of the incision. Finally, iridectomy is performed in the usual way, and the flap of conjunctiva detached in the first stage of the operation is used to cover the second."

FIG. 348.—LAGRANGE'S OPERATION.
Resection of the sclera.

The steps of the operation are depicted in Figs. 347–349.

Lagrange maintains that this sclerecto-iridectomy yields a filtering cicatrix, and that a communication is established between the chamber of the eye and the perichoroidal space and the subconjunctival cellular tissue. It is especially adapted for cases of chronic simple glaucoma. My own experience with this operation has been a very satisfactory one, although there is some doubt whether there is a permanent filtration,

Henderson, for example, believing that the scar soon becomes impermeable owing to an ingrowth of epithelium, and, therefore, unless a fistula is made, filtration ceases.

Herbert's Operation (Wedge-isolation Operation).—Major Herbert has devised an operation which, he is satisfied, produces a permeable scar:

> "After the anterior chamber has been opened by a narrow Graefe knife passed across it horizontally, a short scleral flap is cut, but left attached to its apex. The direction of the knife edge is next changed, so that two cuts forward and backward are made, and a narrow strip of sclera is detached from the flap at the limbus. The whole procedure is subconjunctival, and the wedge of sclera detached is left adherent to the conjunctiva, but holds it loosely in the groove cut in the sclera. To prevent prolapse of the iris a small iridectomy may be performed."

I have had no personal experience with Herbert's operation, and cannot, therefore, express an opinion in regard to its value. It, like Lagrange's procedure, provided it be admitted that they are capable of producing a filtering scar, forms one which differs from the ordinary

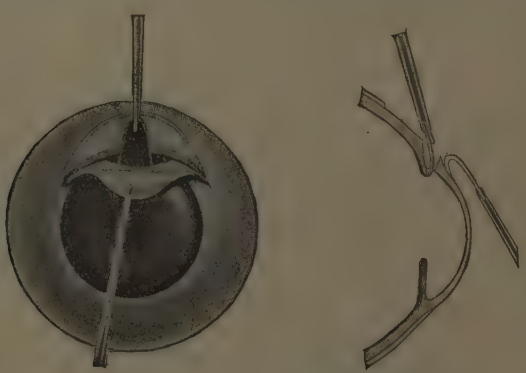


FIG. 349.—LAGRANGE'S OPERATION.
Making the iridectomy.

cystoid cicatrix in that it is free from adhesions to the uveal tract, and this is a matter of vital importance.

As it is sometimes difficult to remove a piece of sclera in the manner described by Lagrange, a number of attempts have been made, and, according to their authors, very satisfactory ones, to perform sclerectomy with a punch-forceps. Such a modification, for example, was proposed by Holth, and after the formation of the corneoscleral flap and the performance of iridectomy, the anterior lip of the wound is cut away by means of a punch-forceps.

Sclerectomy With a Trephine.—Trephining the sclera for the purpose of relieving the increased intra-ocular tension of glaucoma is not a new procedure. Long ago it was proposed by Argyll Robertson, Blanco, and Froelich, but their operations differed in many respects from the newer procedures of scleral trephining which have been suggested, particularly by Fergus and by Elliot.

The technic of Fergus' operation is thus described by A. J. Ballantyne in his admirable review of the newer operations for glaucoma:

"A conjunctival flap is dissected up toward the cornea and laid over the corneal surface, while with a Bowman's trephine a small disc of sclera is removed a millimeter or two from the apparent corneal margin. Next, an iris repositor is passed from the trephine opening into the anterior chamber, keeping it in close contact with the sclera and cornea. The conjunctiva is then replaced and stitched into position."

It will be noted that Fergus' operation adds to trephining the sclera a cyclodialysis.

Another operation, and it would seem a more satisfactory one, in which the trephine opening into the sclera is made as the essential procedure, has been designed and practised by Major R. H. Elliot. This differs from the Fergus operation, with which Major Elliot appears to

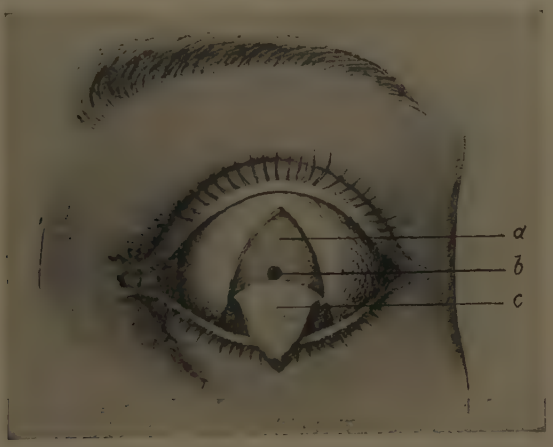


FIG. 350.—ELLIOT'S OPERATION FOR GLAUCOMA. (Wood.)
Second stage of operation: *a*, Raw surface left by raising the conjunctival flap; *b*, trephine hole; *c*, flap of conjunctiva turned down over the cornea.

have been unfamiliar when he published his first results, in that it is a simple trephining, no added procedure like a cyclodialysis forming a part of its technic.

Elliot's Operation (Simple Trephining of the Sclera).—The operation is performed as follows:[1]

A large triangular flap of conjunctiva is dissected up from above the cornea, the incision for which runs concentric with the margin of the corneal margin and ends on either side about 4 mm. below the highest point of the cornea, and the same distance from the inner and outer sides of the limbus. To ensure this it is reflected on to the cornea, and the dissection continues until the rounded edge of the limbus can be seen overhanging the surrounding scleral tissue. In glaucomatous eyes of long standing the separation of the conjunctiva is carried from the cornea to a farther stage with the aid of scissor points. As a result of this maneuver the cornea can be seen to be split; a thin, dark-colored crescent, about 1 mm. in breadth, surrounds the base of the flap, and defines the area over which the splitting has been effected. Once this appearance is recognized, the surgeon may be sure of entering

[1] This has been summarized from Major Elliot's own description (The Ophthalmoscope, August, 1911).

the anterior chamber with the trephine. Throughout the whole of the dissection of the flap it is important to keep the point of the scissors directed toward the plane of the posterior pole of the lens. Otherwise a button-hole in the conjunctival flap may be formed. The area selected for the application of the trephine is next carefully cleaned of connective-tissue tags which are attached to the flap.

The trephine must be applied as close to the limbus as possible. Otherwise the surgeon will fail to enter the anterior chamber with his trephine, and should he so fail, would be obliged to aid his procedure by introducing a curet or other instrument, a procedure which Fergus deliberately combines with his operation, but which Elliot avoids, inasmuch as he desires to make a simple trephining. The trephine opening should not be greater than 2 mm. in diameter, and Major Elliot prefers a 1.5-mm. opening. The trephine should be used with quick, light movements, and care should be taken that its first application serves to make a bite into the sclera before it is raised to see the progress made. Once a clean ring is thus started, it is easy to replace the trephine. The surgeon is made aware of the fact that the chamber has been tapped as soon as the aqueous wells up alongside of the instrument. If the disc of sclera remains attached at one point, it can readily be removed with a snip of a pair of scissors.

Fig. 351.—Stephenson's Sclerectomy Trephines.

Should the iris bulge into the aperture, it may be incised in a radial direction and the aqueous allowed to escape. Frequently the membrane under these circumstances will return, but if it does not, the piece should be abscised. The trephine opening should be carefully cleaned of any attached tags of iris, and if they cannot be removed in the ordinary manner, the use of an irrigator is recommended by Elliot.

After the conjunctival flap is smoothed back into place sutures are unnecessary, unless it tends to curl up or is found misplaced after the first dressing. Usually the instillation of drops after the operation is needless. Should, however, the pupil be displaced upward, a few drops of an eserin solution (4 grains to the ounce) are indicated.

Major Elliot after the third day uses atropin if the pupil is not active and dilated, because he has found in congestive cases a strong tendency to the formation of posterior synechiæ.

This operation has received the commendation of a number of surgeons, and I have secured satisfactory results with it in chronic and secondary glaucoma. I have not employed it in acute glaucoma. An excellent trephine for use in this operation has been designed by Sydney Stephenson (Fig. 351).

Fig. 352.—Verhoeff's Sclerostome, Ready for Use.

To avoid the traumatism of these operations, Verhoeff, of Boston, has devised an instrument called a *sclerostome* (Fig. 352), with which a subconjunctival fistula is produced. The instrument and the manner of using it are depicted in Fig. 353.

Operations for the Relief of Pulsating Exophthalmos.—In the chapter relating to this subject in the previous volume I was inclined to take an extremely favorable view of the orbital operation, that is, ligation of the superior ophthalmic vein, of the inferior ophthalmic vein,

the angular vein, or of the smaller orbital veins, as the case may be, and at the time of writing apparently all operations which included ligature and resection of the superior ophthalmic vein had been successful. This procedure, therefore, was recommended for consideration before ligature of the common carotid (with its mortality of 10 per cent. and failure of 24 per cent.) was resorted to. It was definitely recommended that it should precede ligature of the second common carotid, provided ligature of the first had failed to produce the desired result, because at the time of writing no ultimately unfavorable results had occurred. Since this time, however, one death has taken place due to extension of venous thrombosis into the cranial cavity, and, therefore, the favorable recommendations must be modified in this respect. Recently Zeller insists that the common carotid on the side of the wounded internal carotid and cavernous sinus should be compressed systematically in an effort at curing the aneurysm, and especially as a preliminary to the ligation of the common carotid, a recommendation which had frequently

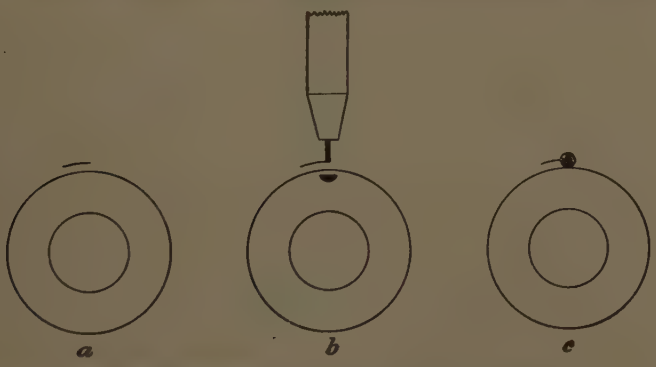


FIG. 353.—MANNER OF USING VERHOEFF'S SCLEROSTOME.
a, Position of incision, conjunctival flap not shown; *b*, sclerostome in position ready to cut; *c*, fistula completed. Buttonhole in iris not shown.

been made long before his paper appeared. He believes that if brain disturbances occur after continued carotid compression, the ligation of this vessel is contraindicated. If success does not follow the compression treatment, he recommends the ligation of the internal carotid on the side of the aneurysm, as near as possible to the base of the skull. He believes that ligation of the second carotid is not a justifiable operation, not only because it is dangerous, but because he believes that upon anatomic and physiologic grounds it cannot have a healing effect. That it is dangerous the statistics of Holloway and myself indicate. We record in 10 double carotid ligations 6 successes, 2 failures, and 2 deaths.

The Relation of Cerebral Decompression to the Relief of the Ocular Manifestations of Increased Intracranial Tension.—The paragraphs which follow should be read in connection with the chapter on "The Eye-ground as a Means of Diagnosis of Intracranial Lesions," in Vol. IV., p. 937, of the present system. The pathogenesis of choked disc or papilledema is still a matter of dispute, but modern in-

vestigation, both clinical and experimental, indicates that those theories which regard papilledema as an inflammatory process, or assume that it is due to an edema propagated from the brain, or that it depends upon a disturbance of the vasomotor innervation of the retinal vessels, need not be seriously considered, while those theories which regard rise in the intracranial pressure as the main factor in the production of choked disc have most to commend them. Whether the changes which are ordinarily known as papilledema depend upon the effect of a direct transmission of the cerebrospinal fluid into the lamina cribrosa, or are due to compression of the vessels as they pass through this structure or the nerve, or are induced by lymph stasis, has not been definitely determined.

Leslie Paton and Gordon Holmes, in their recent communication on this subject, are convinced that their observations establish the fact that papilledema is an edema of the nerve-head, due, on the one hand, to venous engorgement, and, on the other, to lymph stasis. The edema of the papilla, they believe, depends upon venous engorgement which results from the rise of intravenous pressure which is necessary in order that the circulation shall be maintained in the intravaginal portion of the brain where this is subjected to an increased sheath pressure, and this increased sheath pressure obstructs lymph drainage from the papilla.

It would seem that of one thing only are we absolutely sure, namely, that increased intracranial pressure is one great cause of the development of choked disc, and that its release, to quote the language of Sir Victor Horsley, arrests and often cures the disc edema.

Palliative trephining or cerebral decompression may be utilized for the cure of choked disc: first, in tumors of the brain and cerebellum; second, in various types of brain disease and meningitis; third, in injuries of the skull, for example, fractures with or without epidural or subdural hemorrhage; fourth, in syphilis of the brain contents, for example, in gummata, pachymeningitis, and other types of meningitis; fifth, in renal disease and some types of anemia.

Referring now only to the choked disc which occurs as the result of brain tumor, be this situated in the cerebrum or the cerebellum, the various stages into which the process is divided, the frequency with which it occurs, the rapidity with which it develops, the factors which create sudden increase in its elaboration, the period of time which must elapse between the beginning of the growth of a brain tumor and the appearance of choked disc, have been discussed in the previous article.

It is well known that in a certain percentage of cases at the time of examination there is no choked disc, and as we have no means of definitely ascertaining whether or not it will develop, the search for ocular symptoms in the absence of choked disc which would justify a cerebral decompression in the sense of a preventive operation is an important one. It is the custom to speak of the "imminence of neuritis or edema," a term descriptive of a period during which the retinal veins, or only one division of them, become darker, more distended and more unevenly tortuous, and more frequently curved than is normal. This phenomenon has been ascribed to beginning pressure on the vein from the intravaginal

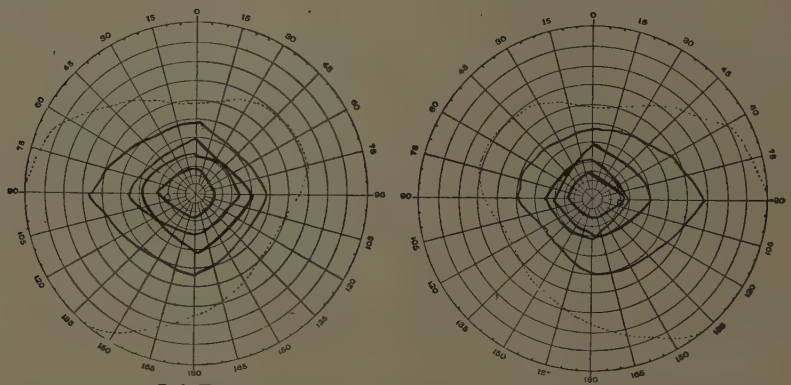
space, and in my experience in a certain number of cases represents a condition of affairs which may antedate even the first stage of papilledema, although Leslie Paton is unconvinced of the importance of this ophthalmoscopic appearance.

Very important is the examination of the field of vision. In general terms it has been known for many years that various types of dyschromatopsia and reversal in the normal sequence of the order in which the color fields are developed may be associated with brain tumor. This observation was probably originally made by Charcot. Similar fields occur in tabes dorsalis, Freidreich's ataxia, and in certain toxemias, notably those produced by lead, alcohol, mercury, bisulphid of carbon, and dinitrobenzol. Such fields are sometimes spoken of as characteristic of hysteria, and although inversion of the color lines is often demonstrable in this psychosis, and may be one of the significant signs of its symptom-complex, it is by no means pathognomonic of it, and, doubtless, has led many a clinician astray in his diagnosis. So frequently has this been the case that Cushing and Bordley maintain "that almost every patient brought for operation after the diagnosis of brain tumor has finally come to be read by the ophthalmoscope, has at one time or another been regarded as hysteric, or the subject of some psychosis."

It is difficult to accept this statement without modification, although doubtless all observers agree that hysteria and brain tumor frequently are difficult differentiations, and all who have had much experience in these examinations know that it is absolutely wrong to assert that because the so-called inversion of the color lines is demonstrable the patient necessarily represents hysteria or any other form of psychosis. Cushing and Bordley and, more recently, Cushing and George J. Heuer have studied this matter with great care and accuracy, and have been impressed with the frequency with which alterations in the color fields, characterized by interlacing of the color lines, color inversion, that is, with the blue field smaller than the red, hemiachromatopsia without corresponding change in the form field, islands of blue-blindness and blue-blindness itself, complete green blindness, and complete achromatopsia may be present with the most incipient stages of choked disc, or, which is more to the point, when there are no recognizable ophthalmoscopic changes in the eye-grounds, and their final conclusion is that such distortions of the color boundaries promise to be of some service in making a precocious diagnosis of increased intracranial tension. Many years ago I described similar visual fields in patients with chronic and persistent headache studied in the service of Weir Mitchell, and doubtless some of these patients were also the subjects of unrecognized brain tumor. Similar observations have been made by Chas. K. Mills.

Where reversal and interweaving of the color lines are due to increased intracranial tension, as they frequently are, cerebral decompression is followed by a restoration of the color fields to their normal sequence. Evidently there should always be a search for this symptom, but with our present means of mapping the color fields it does not seem to me that there is sufficient justification in depending upon this sign

alone as a certain one for recommending a palliative trephining, largely because, even in normal eyes, in many cases of cerebrospinal disease and certain toxemias exactly similar visual field phenomena may be developed.

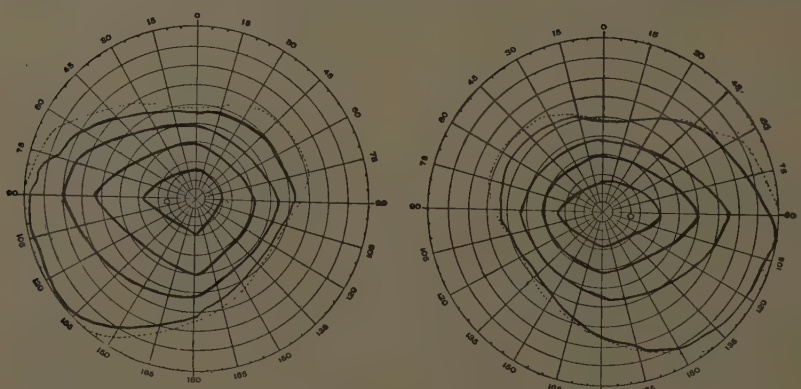


Left Eye. Right Eye.

FIG. 354.—VISUAL FIELDS, BEFORE OPERATION, OF PATIENT IN SERVICE OF C. H. FRAZIER AND W. G. SPILLER IN THE UNIVERSITY HOSPITAL, WITH SYMPTOMS OF CEREBELLOPONTILE ANGLE TUMOR AND WITH HYDROCEPHALUS.

Contraction of form fields and partial reversal of color lines. Double choked discs.

It is important that an investigation of the blind-spot should be made, even before there are any ophthalmoscopic signs of change in the nerve head. The spindle-shaped enlargement of the blind-spot, which is believed by Ramsay and Sutherland to be an early sign of



Left Eye. Right Eye.

FIG. 355.—VISUAL FIELDS OF THE SAME PATIENT AS SHOWN IN FIG. 354 SEVEN MONTHS AFTER SUBTENTORIAL DECOMPRESSION.

All symptoms had disappeared, and visual fields are practically normal.

sympathetic ophthalmia, is significant in this respect, and the beautiful demonstrations of Van der Hoeve, de Kleijn, and others that there may be an enlargement of the blind-spot, or that it may be surrounded in its enlarged state, or without this, by rings of color scotoma in disease of the posterior ethmoidal cells and sphenoid sinus before either optic

neuritis or retrobulbar neuritis develops, and that these phenomena disappear with the relief of the sinus disease, are even more significant in this respect. Some studies made by Holloway and by myself of the size and condition of the blind-spot in patients with suspected brain tumor are as yet too imperfect to ascribe to them any precision in diagnostic methods, but they are not entirely without significance.

The value of the so-called temporary amaurosis in brain tumor has been referred to, especially where this exists prior to the development of choked disc; and Paton has suggested that it is not necessarily on the first development of the papilledema, but on the first sign of visual failure that palliative trephining is indicated if sight is to be saved. It would seem, therefore, correct to conclude that the most satisfactory

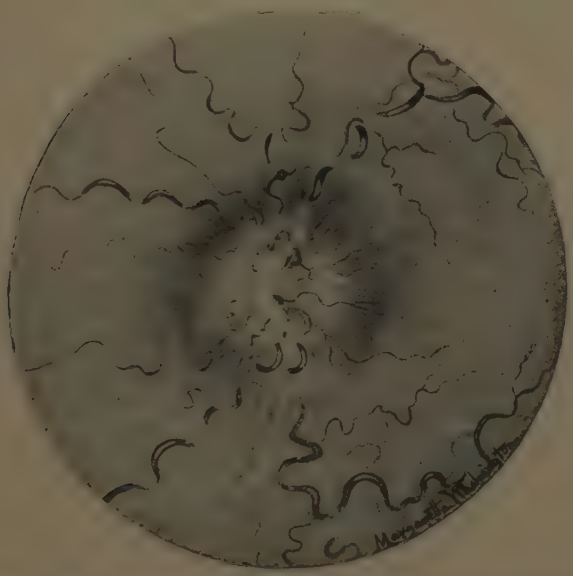


FIG. 356.—FUNDUS OF THE RIGHT EYE OF A PATIENT WITH TUMOR OF THE BRAIN AND CHOKED DISC; SWELLING 6 D. (Service of Dr. Edward Martin in University Hospital, Philadelphia.)

treatment for the purpose of preserving vision in any case of choked disc not due to a toxic process or constitutional disease (infectious optic neuritis), but depending upon increased intracranial tension, is cerebral decompression, with, if possible, an immediate or subsequent removal of the growth; that if the operation can be performed early, that is, during the first or second stage, the prognosis as to sight is fairly good; that the statement that one must wait for the appearance of a choked disc before resorting to this operation must be modified in favor of immediate operation, provided the other symptoms to which I have made reference and the general and neurologic examinations indicate the presence of a lesion that is raising the intracranial tension; and that in non-syphilitic cases time devoted to the administration of iodids and mercurials is time wasted.

In the later stages of choked disc, when there is marked depreciation of vision, advancing optic nerve atrophy, and great contraction of the visual field, although the operation may have to be done for other reasons, the visual prognosis is unfavorable, and occasionally the operation apparently hastens the impending blindness. Sometimes, however, it seems to check it, and there are cases on record in which very defective visual power has been really improved by the operation (Figs. 356, 357).

All head injuries, whether fracture of the skull is present or not, should be carefully investigated from the ophthalmoscopic standpoint, as well as from the other standpoints which have been described. The presence of papilledema, which is sometimes conspicuously evident, is an indication for operation, but not a peremptory one, as sometimes the disc edema subsides without operative interference.

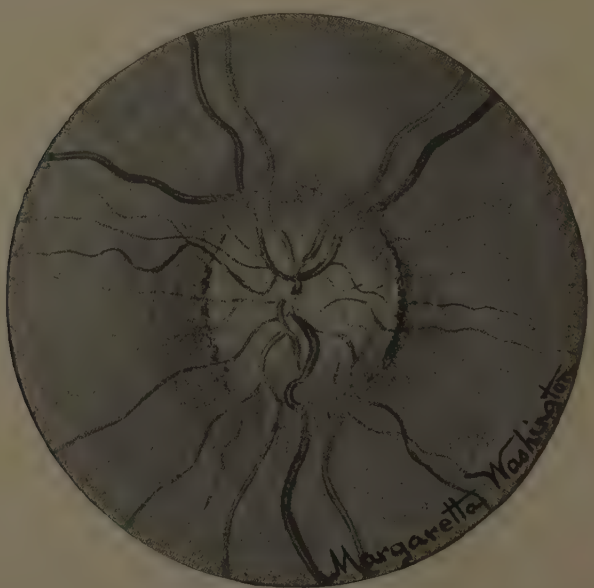


FIG. 357.—FUNDUS OF THE RIGHT EYE OF THE SAME PATIENT AS SHOWN IN FIG. 356 ONE MONTH AFTER DECOMPRESSING TREPHINING.

If the papilledema depends upon a syphilitic brain lesion, a gumma, for example, a thorough mercurial or other antisyphilitic course, lasting from six to eight weeks, is proper. If at the expiration of that time there is no subsidence of the intra-ocular swelling of the disc, cerebral decompression should be considered.

Cushing and Bordley incline to the view that albuminuric retinitis is due in large part to cerebral edema, and that the neuroretinal lesion in nephritis is a modified form of choked disc. Cushing has advised and has performed cerebral decompression for the relief of uremia with choked disc with temporary good results. My own experience in this respect is limited to one patient with extensive albuminuric retinitis, cerebral decompression having been performed without the slightest good result.

It is difficult to believe that a palliative trephining could be of any permanent service in the relief of the visual disabilities of albuminuric retinitis, although there is little doubt that increased intracranial tension may play a rôle in the production of the papillitis with nephritis which may accompany the retinal disease as an added part of the process.

The papilledema of ordinary anemia which has been occasionally observed would not seem to me to indicate a cerebral decompression, and certainly not until the patient had been subjected to a long course of arsenic and iron. I have seen and reported complete restoration of vision under these conditions and with the aid of these remedies.

CHAPTER CXXXIX.

MILITARY SURGERY.[1]

By Lt.-Col. William Cline Borden, M. D., U. S. A.,

Washington, D. C.

Military surgery, in the strictly technical sense, is the application of the principles of the science of surgery to the conditions which obtain in armies.

Military Surgery in Peace.—In time of peace the practice of surgery does not differ materially from that of civil life. The troops are mainly quartered in garrisons where are established fully equipped hospitals provided with the essential requisites for surgical work according to the most approved modern methods.

These provisions for surgical care, at least for all ordinary cases and emergencies, are at hand even at the most remote stations, and are much more adequate than those obtainable in the average country town in even the most thickly settled eastern parts of the United States. For unusual cases and those requiring special care and appliances, general hospitals are established to which such cases may be sent. These hospitals have on their staffs specialists in each line of medical and surgical work, and are provided with all the special appliances found in large and fully equipped civil hospitals.

In the United States there are two such general hospitals, one at Washington, D. C., which serves the eastern part of the country, and one at San Francisco, which provides for the West, and also serves as a receiving and treatment hospital for those cases which cannot be adequately treated on account of climatic or other reasons in the island possessions.

For the Philippines a similar hospital is established in Manila, to which cases are sent from the outlying stations in the different islands.

These general hospitals, being fully equipped and already established, are nuclei for immediate expansion to large size to receive sick and wounded in case of war, and to furnish the necessary reserve accommodations for the sick and injured until the necessary temporary general hospitals are established; both in the field, at the base of operations, and at different places in the home country.

Military Surgery in War.—In time of war the practice of surgery is modified according to the peculiar conditions which then obtain. These conditions may be summarized as follows:

[1] Supplementary to Chapter LXVI., Vol. IV., p. 946.

(1) Peculiarity of the traumatisms received, *i. e.*, gunshot wounds, shell wounds, bayonet and saber wounds.

(2) The peculiar conditions which often obtain with the wounded, *i. e.*, soiled clothing and skin, delayed treatment, depression from lack of food and water, overstrain, etc.

(3) The conditions under which the surgeons often have to work, *i. e.*, overworked during and after battle on account of the great number of wounded to be cared for; working at disadvantage on account of impossibility of obtaining all necessary supplies; difficulty of practising aseptic and antiseptic technic.

(4) The conditions which frequently obtain with the wounded after first treatment, *i. e.*, transportation often for long distances with poor conveyances; insufficient or improper shelter; food not suited to the sick, and insufficient or inadequate material for dressings and proper technic.

To meet all these difficult conditions, with due regard to the science of surgery as it should be applied to each individual case, is the function of the military surgeon.

That this is no light task and that it cannot be adequately done without special training is evident.

The military surgeon must be familiar theoretically, at least, with the traumatisms which he will be called upon to treat, must know the condition which will confront him in his work, and must be able to apply his treatment to the best interests of his patients according to the peculiar environment in which he and they are placed.

Originally, the military surgeon was concerned mainly with the immediate treatment of the wounded only. The sick soldier was left to the more or less tender mercies of the charities of the people of the country through which the army passed. The wounded of the army, after their wounds had been more or less properly dressed, often shared the same fate.

Gradually this was changed by development of the medical departments of armies until both sick and wounded received more or less efficient care by the sanitary services of the armies, and more or less adequate provision was made for their shelter and treatment until their recovery and return to the ranks or their discharge or furlough home.

With the development of hygiene and preventive medicine a new era opened in military methods. It became evident that *the preservation of the health of troops was a most important factor in the efficiency of armies*. The number of rifles upon the fighting line is largely due to the care bestowed on the fighting force between battles. To this is added both in war and peace the economic factor that sick men not only lessen the fighting force, but are a financial burden when sick and a continuous charge upon the nation if permanently disabled, and consequently the recipients of pensions thereafter during life.

With appreciation of these facts, coupled with the ability through modern methods to prevent disease, the *military surgeon* rose to the position of a *medical officer*, whose highest economic and military func-

tion was to prevent disease, and whose humanitarian function remained as before, *i. e.*, to bring to his aid all the resources of medicine and surgery to alleviate suffering, to save life, and to prevent or minimize disability.

It is now evident that a medical officer is a specialist having duties and responsibilities quite different from those which devolve upon a practitioner of medicine or surgery in civil practice. The recent graduate from a medical school is as little fitted for the special duties of a medical officer as he is fitted to assume the duties of a health officer of a large city. Equally, the peculiarities of wounds in war are such that they require for their proper treatment special study which is not given to undergraduates in colleges of medicine.

Realizing this, army medical schools have been established in nearly all countries, where graduates are instructed in the special work required of medical officers. In these there are chairs of military surgery devoted to the teaching of the treatment of the wounded in war, as well as other chairs having to do with medicomilitary affairs.

The Army Medical School for the United States Army, established by Surgeon-General George M. Sternberg, is situated in the city of Washington. Therein are taught hygiene and preventive medicine as applied to armies; military surgery; military medicine; chemical, microscopic, and bacteriologic technic; hospital corps' drill and medical administration, whereby the student doctor of medicine is enabled to become a medical officer and administer the affairs of military hospitals and the hospital corps, and be fitted as he advances in rank for the larger responsibilities which devolve upon brigade, division, and chief surgeons of army corps and armies.

An army is a large and complicated machine. Each part of this machine, while having its special functions, must work in harmony with all other parts and do its own part efficiently, otherwise the effectiveness of the whole is materially or fatally impaired.

The medical department in recent years, with its regimental aid, its dressing stations, its field hospitals and medical supply, its wagon trains, its officers, and enlisted men, has become so large a part of an army as to enter as an important factor in the determination of campaigns and the movements of troops, both in and out of the field of actual campaign.

In the United States the formation of an adequate medical department is fraught with many difficulties, as the medical officers of the regular army are comparatively few in number, and can form but a nucleus for the much larger force required in war, most of which must be recruited from physicians engaged in civil practice who are absolutely unacquainted with matters of administrative detail, and generally but little informed regarding the essentials of sanitation, which pertain to and are of such great importance in massed bodies of soldiery.

The civil practitioner, unless he be a medical officer of the militia, is trained for and occupied with purely medical and surgical matters. When thrown unprepared into a military environment he is bewildered

by the multitudinous and unfamiliar duties, and, until he becomes efficient in these new requirements, passes through a longer or shorter period of greater or less inefficiency. Much of the criticism so freely bestowed upon the working of the medical department of armies, both in this country and in England, is based upon this time of mobilization and preparation when the recently recruited civilian medical force is still, from a military standpoint, ineffective.

The Anglo-Saxons have always disapproved the maintenance of large standing armies and depended upon volunteers or drafting in time of war. From a strictly military standpoint such dependence is as unacceptable as the maintenance of a fighting force so large as to be equal to any emergency is unacceptable to democratic ideals or the opinions of the political economist.

Much study has been made by the military authorities in this country as to the means by which to meet the conditions imposed by a national policy of maintaining a small standing army with its small medical department, and yet be able to form a large army in time of war which shall be promptly adequate.

The first step in this direction has been the working out of plans and the passing of legislation whereby the organized militia can be immediately mobilized and added to the regular army if necessary. The force so made may be augmented by volunteers. This is set forth in Field Service Regulations as follows:

GENERAL ORGANIZATION OF THE ARMY.

"1. The organized land forces of the United States consist of the Regular Army and of the organized militia when called into the military (land) service of the United States.

"2. In peace the Army of the United States consists ordinarily of the Regular Army; but whenever the United States is invaded or in danger of invasion from any foreign nation, or of rebellion against the authority of the United States, or the President is unable with the regular forces at his command to execute the laws of the Union, he may call into the military service of the United States all or any part of the militia organized as a land force.

"In war or when war is imminent, the Army of the United States, after the organized militia has been called into service, may be further augmented by the employment of volunteers.

"After January 1, 1910, the organization, armament, and discipline of the organized militia in the several states, territories, and the District of Columbia will be the same (with some minor exceptions) as that which is now or may hereafter be prescribed for the Regular Army."

The Regular Army of the United States.—The Regular Army consists of general officers, the General Staff Corps, the Adjutant-Generals' Department, an Inspector-General's Department, a Judge-Advocate-General's Department, a Quartermaster's Department, a Subsistence Department, a Medical Department, a Pay Department, a Corps of Engineers, an Ordnance Department, a Signal Corps, the Military

Academy, Chaplains, fifteen regiments of Cavalry, six regiments of Field Artillery, the Coast Artillery Corps, thirty regiments of Infantry, the Porto Rico Regiment of Infantry, and the Philippine Scouts.

The Regular Army is organized for a strength of 100,000 in war, but in time of peace the enlisted strength is reduced. According to the last official report (1911) its active strength was as follows:

General officers.	Colonels.	Lieutenant-colonels.	Majors.	Captains.	First lieutenants.	Second lieutenants.	Chaplains.	Total commissioned.	Enlisted men.
34	123	148	433	1306	1446	957	67	4514	85,392[1]

The Organized Militia.—The organized militia, both in its force and its medical department, is organized as is the Regular Army. It has, however, fewer administrative officers.

These officers consist of the surgeon-generals of the different states and the comparatively few officers required with them for central administrative purposes. The other officers of the medical department are directly attached to the militia regiments. A few field hospitals have been established.

The medical commissioned force of the militia numbers at present (1911) about 700, and the enlisted strength (hospital corps) is approximately 2500.

Volunteer Aid Associations.—In time of war volunteer aid is generally offered and accepted. This aid is of very diversified character, and ranges from individual assistance to organized bodies of workers, together with the use of civil hospitals in whole or part for caring for the sick and wounded sent to them from the front.

The American National Red Cross is the officially recognized volunteer aid association in the United States. It was officially recognized in 1905, and since that time has been in close touch with the War Department. Considerable progress has been made toward definite organization, so that it may render prompt and effective service.

Appointments to the Medical Corps.—As the duties are onerous and the responsibilities great, entrance to the medical corps is very carefully safeguarded, and can be had only by passing strict examinations into the character and attainments of each applicant.

Vacancies in the Medical Corps are filled by appointment to the junior grade (first lieutenant). These appointments are made by the President after the applicant has passed a successful examination and has been recommended by the Surgeon-General.

Permission to appear before the board is obtained by letter to the Adjutant-General of the Army, which must be in the handwriting of the applicant, requesting appointment in the Medical Corps of the Army, giving the date and place of his birth and the place and state of

[1] This does not include the enlisted men of the Medical Department (Hospital Corps), as under the Act of Congress approved March 1, 1887, the enlisted men are not to be counted as part of the strength of the army.

which he is a permanent resident, and inclosing certificates, based on personal acquaintance, from at least two reputable persons as to his citizenship, character, and habits.

An applicant for appointment in the Medical Corps of the Army must be between twenty-two and thirty years of age, a citizen of the United States, and a graduate of a reputable medical school legally authorized to confer the degree of doctor of medicine, in evidence of which his diploma must be submitted to the board at the time of his preliminary examination.

Hospital training and practical experience in the practice of medicine, surgery, and obstetrics are essential, and an applicant is required to present evidence that he has had at least one year's hospital experience after graduation.

The examination consists of two parts, a preliminary examination and a final or qualifying examination, as hereinafter described, with a course of instruction at the Army Medical School intervening.

The preliminaty examination is as follows:

(*a*) *Physical.*—The physical examination is thorough, and conforms to that generally required for a commission in the army.

(*b*) A written examination on the following subjects: Mathematics (arithmetic, algebra, and plane geometry), geography, history (especially of the United States), general literature, Latin grammar, and the reading of easy Latin prose. English grammar, orthography, and composition will be determined from the applicant's examination papers.

This examination may be omitted in the case of applicants holding diplomas or certificates from reputable literary or scientific colleges, normal schools, or high schools, or of graduates of medical schools which require an entrance examination satisfactory to the faculty of the Army Medical School.

(*c*) A written examination in the following subjects: Anatomy, physiology and histology, chemistry and physics, materia medica and therapeutics, surgery, practice of medicine, obstetrics, and gynecology.

The preliminary examinations are conducted by boards of medical officers at the larger military stations in the United States.

Applicants who attain a general average of not less than 80 per cent. in the preliminary examinations, and are deemed otherwise acceptable, are appointed to the Medical Reserve Corps with the rank of first lieutenant, and ordered to the Army Medical School, Washington, D. C., for instruction as candidates for admission to the Medical Corps of the Army.

The final examination for commission is given at the end of the course at the school, and comprises the subjects taught in the school, namely: Duties of medical officers, customs of the service, military hygiene, clinical microscopy and bacteriology, military surgery, military and tropical medicine, sanitary chemistry, hospital corps drill, operative surgery, ophthalmology, optometry, and *x*-ray work.

Candidates who, in the final examination, obtain a general average of 80 per cent. and upward are given certificates of graduation at the school,

and those whose aptitude, as determined by the faculty, is deemed satisfactory, and who, in addition to their final examination, pass a successful clinical examination, are selected for commissions in the Medical Corps.

FIG. 358.—AMBULANCE DRILL, UNITED STATES ARMY MEDICAL SCHOOL.

Education and Training of the Medical Officer.—In many countries the medical officers receive their entire medical education in service schools.

FIG. 359.—CHEMICAL DEPARTMENT OF THE ARMY MEDICAL SCHOOL.

In the United States medical officers of the regular army and militia are graduated physicians when they enter the service.

To prepare and perfect physicians who enter the service for the duties required of them the Army Medical School, Washington, D. C., the Field

Service School and the Field Service and Correspondence School for Medical Officers, Fort Leavenworth, Kansas, have been established.

The **Army Medical School** is for the instruction of candidates for the Medical Corps who have passed the preliminary examination, for such officers of the Medical Corps as obtain permission to attend, and for officers of the organized militia. The student body is mainly composed of candidates for admission to the Medical Corps, although a few medical officers of the militia are usually in attendance. These militia officers while at the school receive pay and allowances in addition to tuition. The opportunity for postgraduate instruction is, therefore, an exceptional one, and should be largely embraced by militia medical officers.

The instruction at the school is designed to prepare the students for those duties which the medical officer is called upon to perform, and in which the graduate of the civil medical school is usually not informed or not sufficiently proficient for medical military purposes.

The course is given annually for eight months, beginning October 1st. It embraces the following subjects:

(1) Duties of medical officers, medical department administration, and customs of the service.
(2) Military hygiene.
(3) Clinical microscopy and bacteriology.
(4) Military surgery.
(5) Military and tropical medicine.
(6) Sanitary chemistry.
(7) Hospital corps drill.
(8) Operative surgery.
(9) Ophthalmology and optometry.
(10) *x*-Ray work.
(11) Equitation.

The Field Service School and Correspondence School for Medical Officers at Fort Leavenworth, Kansas, were organized in 1910, and are designed to prepare medical officers for the difficult duties incident to field and campaign. The establishment of these schools mark a decided advance in the education of the medical officer.

The object of the Field Service School and the instruction given is set forth in orders as follows:

"*Officers.*—Its object is the preparation of officers of the medical corps and of medical officers of the organized militia for the better performance of their duties as administrative and staff officers on field service, and to make research into such subjects as may concern medical officers under field conditions.

"*Student Officers.*

"Selection of student officers will be made as follows:

"(*a*) The Surgeon-general will submit to the Adjutant-general of the Army, not later than January 1st of each year, the names of not

Schedule of Lectures and Laboratory Instruction at the Army Medical School, Session 1910–1911.

A. M.

Monday.	Tuesday.	Wednesday.	Thursday.	Friday.	Saturday.
9 to 12. Clinical microscopy, bacteriology, pathology.	9 to 12. Sanitary chemistry.	9 to 12. Clinical microscopy, bacteriology, pathology.	9 to 12. Sanitary chemistry.	9 to 12. Clinical microscopy, bacteriology, pathology.	10 to 11. Military surgery. Oct. 22, '10, to Mar. 18, '11. 11 to 12. Military hygiene. Oct. 22, '10, to Mar. 18, '11.

P. M.

1.30 to 2.30. FIRST AND SECOND SECTIONS: Ophthalmology and optometry. Oct. 3, '10, to May 15, '11. 2.30 to 4. SECOND SECTION: Operative surgery. Oct. 10, '10, to Jan. 30, '11. *x*-Ray. Feb. 6, '11, to May 1, '11.	1.30 to 3. FIRST SECTION: Operative surgery. Oct. 18, '10, to Jan. 31, '11. *x*-Ray. Feb. 7, '11, to May 2, '11. 3 to 4. ENTIRE CLASS: Military law. Jan. 3, '11, to Feb. 1, '11.	1.30 to 2.30. FIRST AND SECOND SECTIONS: Ophthalmology and optometry. Oct. 5, '10, to May 17, '11. 2.30 to 4.30. ENTIRE CLASS: Medical department administration. Oct. 5, '10, to May 15, '11.	2 to 4. FIRST AND SECOND SECTIONS: Hospital corps drill and field work. Oct. 6, '10, to Mar. 30, '11. 1.30 to 2.30. THIRD SECTION: Equitation. Oct. 6, '10, to Mar. 30, '11. 2.30 to 3.30. FOURTH SECTION: Equitation. Oct. 6, '10, to Mar. 30, '11. 2 to 4. ENTIRE CLASS: Hospital corps drill and field work. Apr. 6, '11, to May 11, '11.	1 to 2. ENTIRE CLASS: Military and tropical medicine. Oct. 7, '10, to Feb. 24, '11. 2.30 to 4.30. ENTIRE CLASS: Medical department administration. Oct. 7, '10, to Feb. 24, '11. 1 to 3. ENTIRE CLASS: Medical department administration. March 3, '11 to May 12, '11.	2 to 4. THIRD AND FOURTH SECTIONS: Hospital corps drill and field work. Oct. 8, '10, to April 1, '11. 1.30 to 2.30. FIRST SECTION: Equitation. Oct. 15, '10, to April 1, '11. 2.30 to 3.30. SECOND SECTION: Equitation. Oct. 15, '10, to April 1, '11.

less than four nor more than eight officers of the medical corps whom he recommends for detail for instruction in the school.

"(*b*) Medical officers of the organized militia who may apply for entrance and whose admission may receive the approval of the Secretary of War, not to exceed a total of six in any one session, may also be detailed for instruction in the school, subject to the provisions of paragraphs 6, 11, 13, 14, 15, 16, and 17, General Orders, No. 69, War Department, 1910.

"*Course of Study.*

"The course of study will be conducted under the three existing departments of the Army Staff College as follows:

"I. The Department of Care of Troops.

"II. The Department of Military Art.

"III. The Department of Engineering.

"I. *Department of Care of Troops.*

"The course will comprise the following subjects or fields of inquiry:

"(*a*) Duties of the medical department in the field; general sanitary organization; the details of organization of the various sanitary units; the functions of administrative medical officers, sanitary equipment and supply; the transportation service of the front; range of modern weapons; battle casualty percentages; location and function of mobile relief organizations during action; sanitary service of the line of communications and of the base; the use of the Red Cross and other voluntary aid associations.

"Instruction will be by lectures, conferences, problems, terrain exercises, and the practical use and direction of organized field sanitary units.

"(*b*) The civil function of the medical department in occupied territory.

"Instruction will be by conferences and problems.

"(*c*) The preparation of a scheme for the organization, equipment, and supply of the medical department of a large military force, either expeditionary or on the defensive.

"Instruction will be by conferences and problems.

"II. *Department of Military Art.*

"The course will comprise the following subjects:

"(*a*) Organization and administration of troops in the field; orders; the elementary principles of tactics; staff administration and supply.

"Instruction will be by lectures, demonstrations, tactical and staff rides.

"(*b*) In co-operation with the department of care of troops there will be at least one maneuver on map or terrain to illustrate the relation of the sanitary service to the military forces as a whole.

"III. *Department of Engineering.*

"The course will comprise theoretic and practical work in the following subjects:

"(*a*) Military topography, map reading; the principles and practice involved in the use of all classes of maps for military purposes.

"Instruction will be by lectures, conferences, practical examinations, and studies of terrain.

"(*b*) Military topography, sketching; the principles and practice involved in the rapid making of simple road and position sketches.

"Instruction will be by lectures, conferences, and brief field practice."

An Army Service Correspondence School is also in operation at Fort Leavenworth for the instruction of designated officers who cannot be spared from their posts to take the course in the field service school, the number of officers who can be spared to attend the latter school being limited. Students of the correspondence school are given practical problems in field work to solve from time to time. These solutions are turned in to the instructors in the field service school.

The instruction of the regular medical officer therefore comprises: (1) his premedical education, academic or collegiate, or both; (2) his medical college courses for the degree of M. D., (3) his course at the Army Medical School, and (4) instruction at one of the field service schools. To this is added the experience gained by work in maneuver camps, practice marches, and continued service with troops, as well as the individual study of medicomilitary matters which he must pursue to prepare himself for the examinations for promotion which he is obliged to pass in order to be promoted through the different grades up to that of colonel.

As a result of this the one time doctor of medicine becomes a medicomilitary specialist, *i. e.*, a medical officer.

The Medical Reserve Corps.—The Medical Reserve Corps was organized in 1908 for the purpose of supplementing the regular medical corps and securing a body of selected practitioners of medicine from whom men can be procured to meet the demands in excess of those met by the fixed and limited number of officers of the Medical Corps. The members of the reserve corps may be called upon for service whenever required to meet unusual demands in time of peace; in epidemics; care of troops at small stations; examinations of recruits where no medical corps officer is available, etc. They may also be called into service to bring the Medical Department to proper size in insurrections and small wars, where increase in the upper (administrative) grades is not necessary.

Appointment to and commission in the Medical Reserve Corps is open to any graduate of a reputable school of medicine who is physically, mentally, and morally qualified.

All officers of this corps rank as first lieutenants, and their commissions confer upon the holders when on active duty all the authorities, rights, and privileges of the like grade in the Medical Corps.

Permission to take examination for commission in the Reserve Corps is given upon application approved by the Surgeon-general. Appointments in the Medical Reserve Corps are made by the President after the applicant has passed the prescribed examination and has been recommended by the Surgeon-general.

The physical examination conforms to that of the Medical Corps.

The professional examination consists of an oral examination in the following subjects: practice of medicine, surgery, obstetrics, gynecology, and hygiene.

Should the oral examination in any subject be unsatisfactory, the applicant may be permitted to take a written examination in that subject.

The establishment of the medical reserve corps was a great step toward providing a body of selected men who can be called upon for more or less temporary service in order to meet the varying demands of the regular army.

Contract Surgeons.—The employment of surgeons by contract is still authorized, but is little practised, and only at very small posts or for temporary emergency, as their place has been taken by the officers of the Medical Reserve Corps, who, carefully selected and with definite rank and position, can render much more effective service.

Pay and Emoluments of Medical Officers.—A young man recently graduated when considering entering the army medical service naturally weighs the advantages and disadvantages as compared with those of civil life.

Briefly it may be stated that a commission in the Medical Corps insures an honorable and adequate livelihood, provided the holder thereof conducts himself well both personally and professionally.

To each rank attained by a medical officer is attached a fixed annual salary, which is received in monthly payments, and this is increased by 10 per cent. for each period of five years' service until a maximum of 40 per cent. is reached. A first lieutenant receives $2000 per annum, or $166.66 monthly. At the end of three years he is promoted to captain and receives $2400 a year. In two years more he receives an increase of 10 per cent. for five years' service, making $2640, or $220 per month. After ten years' service the pay would be $2880 annually, or $240 per month. The rank of major is usually attained in twelve to fifteen years. The pay of a major is $3000 a year, which, with 10 per cent. added for each five years' service, becomes $3600 after ten years' service, $3900 after fifteen years' service, and $4000 after twenty years. The monthly pay of lieutenant-colonel, colonel, and brigadier-general is $375, $416.66, and $500 respectively.

Officers, in addition to their pay, are furnished with a liberal allowance of quarters according to rank, either in kind, or, where no suitable government building is available, by commutation; fuel and light therefor are also provided.

When traveling on duty an officer receives mileage for the distance traveled, including the travel performed in joining first station after

appointment as first lieutenant; the amount allowed is usually sufficient to cover all expenses of the journey. On change of station he is entitled to transportation for professional books and papers and a reasonable amount of baggage at government expense. Mounted officers, including all officers of the Medical Corps, are provided with forage, stabling, and transporation for horses owned and actually kept by them, not exceeding two for all ranks below that of brigadier. Horses and horse equipments are furnished by the government for all mounted officers below the grade of major. Groceries and other articles may be purchased from the commissary at about wholesale cost price. Instruments and appliances are liberally supplied for the use of medical officers in the performance of their duties. Well-selected professional libraries are supplied to each hospital, and standard modern publications on medical and surgical subjects are added from time to time; current issues of a number of representative medical journals are also furnished for use of medical officers.

When the service permits, leave of absence on full pay is allowed at the rate of one month a year, and this when not taken may accumulate to a maximum of four months, which at the end of four years is then available as one continuous leave. Beyond this an officer may still be absent with permission on half-pay. Absence from duty on account of sickness involves no loss of pay.

Medical officers are entitled to the privilege of retirement after forty years' service, or at any time for disability incurred in the line of duty. On attaining the age of sixty-four, they are placed upon the retired list by virtue of law. Retired officers receive three-fourths of the pay of their grade (salary and increase) at the time of retirement.

When medical officers with the rank of captain approach the period of their examination for promotion to a majority they are usually assigned to duty as attending surgeons at or near the principal medical centers of the United States, to enable them to become familiar with the practice of the leading physicians and surgeons of this country, and to attend medical lectures, meetings of medical societies, etc. These assignments are made for one year only, in order that as many medical officers as possible may be enabled to avail themselves of the advantages thereby afforded.

It will be seen that the medical officer not only receives fair pay, but is saved many expenses incident to practice in civil life. Books, instruments, and medicines are all furnished; a house is supplied, forage for his horses, if he owns any, is given, and his travel expenses are paid. These perquisites amount annually to a considerable sum, conservatively estimated at $1200 in the lower grades to $1800 or more in the higher.

In addition, his commission acts as a permanent insurance for life against loss from sickness and disability, as an annuity for old age, and as a life insurance. For if sick, pay and emoluments go on as before; if permanently disabled the officer is retired on three-fourths pay; if he remains in the service until sixty-four years of age he is retired on like

pay for the remainder of his life, and if he dies in service or from disability incident thereto his widow receives one-half a year's salary and a modest monthly pension.

The actual pay received is, therefore, but a moderate part of the reward insured for service, and the young medical man when contemplating a medicomilitary career should bear this in mind.

Briefly, it may be stated that in the first years the rewards are greater than those usual in civil life, and in later years, while probably more than equal to those had by the average practitioner, are considerably less than those obtained by the more successful members of the profession in civil life.

In regard to opportunities for attainment, the service offers opportunities equal to those of civil life, as is evidenced by the monumental Medical and Surgical History of the War of the Rebellion by Otis, the bacteriologic work of Sternberg, the medical epoch-making discovery of the method of transmission of yellow fever by Reed, and the great sanitary work of Gorgas.

The Medical Service in War.—The duties, organization, and working of the medical department in war are quite fully set forth in Vol. IV., p. 946, of this work.

Sanitary Service.—Following the discovery of the method of transmission of malaria and yellow fever, the greatest advance made in recent years in the hygiene of armies has been prophylactic control of typhoid fever in troops by the use of antityphoid vaccine. Of all diseases, typhoid has, in recent years, been most dreaded in armies. The difficulty of controlling its spread, the great inroads it makes upon the fighting strength of an army, and the high pension list which results from the disabilities it causes, as well as the humanitarian considerations involved, make its appearance in an army most disastrous.

It now appears that this dread disease can be practically controlled, and the means by which this has been attained can best be given by quotations from an article by Major F. F. Russell, M. C., U. S. A., whose recent work with the antityphoid vaccine has been of first importance. He writes as follows:

"In 1896, owing to the discovery of agglutinins by Grubler and Durham, our knowledge of typhoid immunity advanced rapidly. In the same year Pfeiffer and Kolle immunized two men against typhoid and made complete and comprehensive studies of the blood changes following inoculation with killed cultures. A few weeks before Pfeiffer and Kolle's experiments became public, Sir A. E. Wright, at that time connected with the English Army, inoculated two men with killed typhoid bacilli, but his studies were apparently on the coagulability of the blood, since no report was made of the specific changes in the blood-serum. In the next year, 1897, he launched the present antityphoid campaign in a publication describing the inoculation of 18 persons. In 1898, on the outbreak of the Boer War, the vaccination was carried out on troops destined for South Africa. Wright furnished some 400,000 doses, and it is understood that 100,000 men were inoculated one or more times.

"While the results were unquestionably good, the incidence of the disease being diminished approximately one-half and the mortality nearly two-thirds, they were not as satisfactory as had been expected. The effects of the inoculations in some organizations of the English Army in South Africa were, however, quite unsatisfactory, in a few instances it even seeming to do harm by apparently increasing the susceptibility to infection.

"The next extensive use of the measure was in the German Colonial Army in Southwest Africa during the Herero Campaign, from 1904 to 1907. The army, being composed of but 16,500 men, was greatly handicapped by the spread of typhoid among them. The matter was laid before Prof. R. Koch, who advised prophylactic vaccination, but as the measure was entirely voluntary, only about one-half the command (7287) accepted it. The same degree of protection was obtained as in the Boer War. This closes the first period in the history of typhoid vaccination. The present period began in 1904, with the work of Sir William B. Leishman, of the Royal Medical Army Corps, who published such remarkably good results in the Corps Journal in 1907 that our attention was again drawn to the matter. In the summer of 1908 the writer was permitted to visit the laboratory of Colonel Leishman and given every opportunity to study his methods and results.

"In the fall of 1908 we fitted up a special laboratory at the Army Medical School in Washington for the preparation of vaccine on a large scale, and in February, 1909, began the vaccination of all applicants. At first volunteers were obtained with difficulty, and it was only through the loyalty of the medical officers in town, who came bringing their wives, children, and servants, that we succeeded in arousing interest. In this way about 150 persons were vaccinated, almost all of whom became active missionaries in the cause. By the end of 1909 we had given 5106 doses to 1987 persons; of these, 77 per cent. received three doses, 17 per cent. two doses, and only 6 per cent. failed to take more than one. During the present year (1910) we have given (up to Dec. 1, 1910) 39,000 doses to 14,286 persons, and although the vaccine has been administered by several hundred physicians located in many different places, no untoward results have been reported from the entire series.

"Among the 14,000 persons vaccinated, there have been reported to date 6 cases of typhoid with no deaths, while among the remainder of the army during the same length of time there have been 418 cases with 32 deaths. The rate per thousand among the vaccinated is approximately 0.4, while among the unvaccinated it is 6 or 15 times as high. Only one-sixth of the force has been immunized; had the entire army been vaccinated, the same rate of incidence would have given only 36 cases rather than 418." (Boston Med. and Surg. Jour., Jan. 5, 1911.)

Since the above was written the use of antityphoid vaccine as one of the greatest advances in disease prevention in armies has been verified by an experience unique in the history of military medicine.

In 1911 a division of 18,000 men was camped for several months near the Mexican border. These men were all given an antityphoid vaccine prepared by Russell and his associates in the laboratory of the Army Medical School, and but 1 case appeared in the entire vaccinated force. The remarkableness of this result is all the more evident when compared with the fact that during the Spanish-American War in 120,000 men there were 20,000 cases, with 1400 deaths.

The **treatment of wounds in war** is quite generally covered in Vol. IV. of this work, pp. 965–1017. Since that section was written but three factors in war wounds and their treatment have been advanced which are of moment. These are: (1) The adoption of a new bullet by the armies of England, Germany, and the United States; (2) the great use of hand and rifle grenades in war; (3) the general introduction of iodin into surgical technic.

The New Rifle Bullet.—As the rifle is the arm which produces the greatest number of wounds in war, the size, shape, weight, and velocity of its projectile is of particular interest in military surgery. The ordnance experts have constantly striven to increase the range and flatten the trajectory of the rifle, and this has lead to improvements in the arm and changes in the bullet. These changes up to the last one are shown on p. 973, Vol. IV.

The new bullet ("Model 1906") is of the same caliber as the model immediately preceding, but is shorter, lighter, has a higher velocity, and the point is much sharper. Its length is but 1.08 inches as against 1.25 inches for the model of 1903; its weight is 150 grains as against 220 grains of its predecessor, and its muzzle velocity is 2700 yards per second, or 400 yards greater. Its structure is as before, being a core of lead and tin composition inclosed in a jacket of cupronickel.

The charge is of pyrocellulose composition, very similar to the powder used for propelling charges in field and seacoast guns.

The grains are cylindric, single, perforated, and graphited. The normal charge weighs from 47 to 50 grains, varying with the lot of powder used. By the use of this cartridge (powder and bullet) the trajectory has been materially flattened and the point-blank danger space has been raised to 718.6 yards. At 1000 yards the bullet will penetrate 12.8 inches of pine, and at 100 yards will penetrate a steel plate 0.3843 inch thick.

Traumas by the New Bullet.—When the shorter, lighter, and sharper new bullet is used, the general character of the wounds will be consid-

FIG. 360.—UNITED STATES BALL CARTRIDGE, MODEL OF 1906.
Cut showing cartridge sectioned to show contained powder, metal case, and bullet.

erably different from the wounds made by the longer, heavier, and blunter bullet. The ogival head of the older bullet allowed sufficient weight forward, and this, with its length, made a well-balanced bullet which, under ordinary conditions, held its course head on.

The new bullet, being short with a long pointed head, has its center of gravity well back toward its base. In consequence its point is easily deflected, causing the missile to be turned from its direct path, or, what is of more importance, the point (head of the bullet) is easily turned backward, causing the bullet to crash sideways through the tissues. Colonel LaGarde, in experiments at the Army Medical School, has found that the skin of the abdomen of a cadaver or the soft bones of the ankle are sufficient to cause the bullet to turn in this way, in which case the missile tears its way sideways through the tissues, causing extensive destruction and wide, ugly wounds in the tissues and viscera, quite different from the small, clean-cut perforations made by the older bullets.

In consequence, in war, if this new missile is used, we may expect to see many wounds large in extent and in amount of tissue destruction which will resemble the wounds made by the "deformable" bullets whose use is forbidden in civilized warfare. This destructive effect of

the missile will increase the proportion of those killed outright, and will render recovery in the wounded more doubtful.

Hand Grenades and Rifle Grenades.—In the Russo-Japanese War hand grenades and grenades fired from the muzzle of the rifle were so largely used as to introduce practically a new factor in war and in military surgery. The rifle is not a good weapon for close fighting, as its bullet is effective only in the line of its flight, while the grenade in exploding, like the Shrapnel, scatters missiles in every direction. Recognizing this, soldiers will in future be supplied with hand or rifle grenades. The latter, when fixed to and fired from the muzzle of the rifle by the discharge of a small blank cartridge, are thrown some distance, there to explode with great destructiveness.

The fragments from these grenades produce ugly lacerated wounds, usually infected, and more difficult of treatment than ordinary bullet wounds. Some military experts estimate that in future wars as high as 30 per cent. of all wounds will be caused by grenades and Shrapnel, and if this should be the case the number of dangerous wounds will be greatly increased.

Iodin in Military Surgery.—The gradual increase in the employment of iodin in aseptic and antiseptic surgery which has recently taken place, due to its effectiveness, ease of use, and simplicity of technic, brings this agent to the forefront in emergency surgery, and, hence, also in military surgery, which is so largely of an emergency nature. With iodin used in 50 per cent. strength of the tincture the slow, difficult, and tedious preparation of the skin by washing and the application of bichlorid solutions becomes unnecessary. The main desideratum is a *dry field*, so that the solution of iodin may penetrate the recesses of the epidermis. The immediate application of the solution to the skin when the skin is ordinarily clean, without the delay and difficulty of previous preparation, is of the greatest advantage in emergency or other surgical work. When the skin is soiled, a rapid washing, not with water, which will saturate the skin and prevent penetration of the iodin solution, but with alcohol, will quickly prepare the surgical field.

Wounds can be covered or plugged with gauze saturated with iodin solution, so favoring antisepsis and preventing contamination.

Altogether, iodin in solution appears to be the most ideal military surgical antiseptic so far known.

Recognizing its value, it has recently been adopted by the Medical Department, and is regularly furnished for use in the field.

It is issued in hermetically sealed glass tubes, each tube containing 1 gram of iodin and $1\frac{1}{2}$ grams of potassium iodid. By dissolving the contents of a tube in 50 c.c. of water or alcohol a solution of strength for ordinary use is obtained. Printed directions are on each tube. Ten of these tubes are carried in the hospital corps pouch by each private of the hospital corps, each medical officer's orderly has a like supply, each regimental medical outfit has 120 tubes, each field hospital 200 tubes, each dressing station 240 tubes, and there are 600 tubes in reserve for each division.

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CHAPTER CXL.

NAVAL SURGERY.*

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Introduction.—No branch of science is more subject to change than that of naval warfare. In fact, the changes follow each other with such rapidity as to completely revolutionize ideas and standards, often within comparatively short periods of time. With many, if not all, of these improvements the Medical Department must keep pace if it is adequately to co-operate with the fighting force in contributing its quota to military efficiency and all that has to do with making the winning of battles possible.[28]

Since the publication of Vol. IV. of Keen's System of Surgery, which contains the original chapter on Naval Surgery, this distinctly special branch of the "Surgery of Warfare" has experienced modification and improvement in hitherto approved procedures of action, independent of the advances in general medical science as applicable under naval conditions, and has also been marked by very definite achievements toward the solution of perplexing problems and the realization of its possibilities in a broader field of usefulness to the service, and nation, and to humanity.

The development that has taken place in the Medical Department of the navy during the past few years, therefore, is of sufficient moment not only to justify, but to require the preparation of a supplementary chapter, in order that this subject may be brought up to date.

In this connection it is important to attribute the solid progress upon which I base this discussion to Charles F. Stokes, Surgeon-general, United States Navy, whose actual and practical accomplishments since appointment to office, and whose speeches in exposition of policy and hearing before the House Naval Committee† and written contributions to this subject, particularly his chapter in the "American Practice of Surgery," I have freely consulted. He has given more careful study to the questions involved than, perhaps, any other naval surgeon, and to the task of solving difficulties incident to the practice of medicine (the term is used in its broadest sense) under conditions peculiar to the Navy and to the requirements of the hour in the emergency of battle, he has devoted an active and practical mind and much ingenuity. These facts, together with the position which he occupies in relation to the

* Supplementary to Chapter LXVII., Vol. IV., p. 1018.

† Committee on Naval Affairs, No. 4, Washington, D. C., Dec. 10, 1910.

naval service, make his views of general value and his program authoratative within the United States Navy. Through the influence of his personal reputation and his clear representations he has stimulated a recognition of the Medical Department as a co-ordinate and co-operative (not subordinate) branch of the service, and pronounced and demonstrated its right to consideration in any war plan, as standing, by virtue of what it has done and is doing to promote military efficiency, in the front rank of the fighting arm of the nation. Indeed, anything short of this would be intolerable to the nation from the single point of view of threatened unpreparedness, for any disregard of the sanitary features of the problem of war entails a one-sided development, an incomplete organization, likely to break down under actual battle conditions.[28]

A recognition of the Medical Department's important function in time of peace and in preparation for and during war is the first step, therefore, toward effective organization, and with this secured, the formulation of plans and the provision of means for their execution become simple. This, then, is largely at the bottom of the recent development which is to be outlined.

The following pages under this heading will be both in supplement to and in modification of the original chapter in Vol. IV., and, with a view to aiding the reader in his search for all information in every subdivision of the subject, the sequence there observed will be repeated as closely as possible.

To begin with, and before taking up the several features of the subject discussed in Vol. IV., it is deemed advisable, in the interest of a fuller knowledge of the field of practice offered in the naval service, to interject some new and relevant matter, which, for lack of space, was excluded in the preparation of the original chapter.

I. **Duties of Medical Corps Under Ordinary Circumstances of Service.**—The range of these and degree of responsibility imposed by each is such as to require great breadth of training, ready adaptability, the utmost vigilance, and an active, discriminating intelligence. The tendency to specialization cannot be, nor is it proper or wise that it should be, entirely evaded, yet, specialization, in its accepted sense and to the degree observed in civil practice, is not possible in the navy, as every medical officer must be self-reliant and competent to perform any duty to which he may be assigned, and to care for any medical or surgical condition that may be presented.[23] This requirement cannot be overlooked by any individual. A medical officer may be assigned to duty either ashore or afloat, and besides the regular stations, such as hospitals, navy yards, recruiting offices and ships, there is a great variety of special and general duties to which he may be detailed, such as the charge of the financial interests connected with the running of the Medical Department; the keeping of accurate records for medical purposes and the preservation of data by means of which subsequent claims for pensions may be decided; the care of all kinds of property; the maintenance of discipline; the instruction of subordinates; duty on courts-martial and boards of examination or survey; expedi-

tionary duty with landing parties; and such sanitary work as conditions require. "In these places he may suddenly be called upon to pass judgment on any subject falling within the broad domain of medicine, since all matters relating, however remotely, to the health of the personnel are referred to him."[29] He is charged with the care of the enlisted force and officers, in which his first duty is preventive in character. He must give first aid to large numbers of civil employes at navy yards and stations, either at home or abroad, and he is often obliged to render sanitary and medical services to large dependent native communities, as at Guam and certain other of our island possessions. There arises not only the necessity for the management of diseases and conditions peculiar to seafaring men, but also for some knowledge of all the specialities in medicine, including diseases of women and children. There is need of a familiarity not only with the diseases prevalent in the United States, but also with those peculiar to foreign countries, particularly of tropical latitudes. Finally, there is need of an acquaintance with quarantine regulations of different countries, international law, the provisions of the Geneva Convention and the Hague Conference, and the sociologic as well as the medical aspects of all nations.[2] The unusual services required upon one occasion may be obstetric, medicolegal, or chemical in nature; at another time they may involve the care of a surgical emergency, the treatment of wounds by venomous fish, or the handling of an epidemic.[29] He is often in such an isolated situation as to be denied the assistance of reference libraries or consultants, and under such circumstances "he must draw from his stock of assimilated knowledge and be ready to shoulder sole responsibility for his judgment and decisions," no matter what the character of the problem.

But of all the duties of the medical corps, the one which bears most directly upon the question of physical efficiency in relation to these supreme moments for which the navy exists, is that of recruiting. The standard observed in this procedure determines the state of health and represents the foundation upon which the structure of the whole establishment is builded.[22] Effort must be made to secure that potentiality of physical stamina which is so necessary in a service of uncertain and sharply varying demands upon endurance and all those human faculties which play an important rôle in victorious conflict.[24] Any compromise with rigid requirements would result only in a poor return to the government, *i. e.*, inadequate service primarily, with great loss of time and great expense and embarrassment to the naval service in the end.[21] No care in training subsequent to enlistment could fully compensate for laxity in recruiting. "Resistance to disease and the manifold effects of injuries can be predicted only in a hardy physique, and the issue of any military enterprise thus becomes largely dependent on the manner in which the duties of the medical corps have been performed" at the recruiting station, and the success attained in trying to bring "every man to his post of battle in a state of the highest vigor."[29]

II. **Battleship Conditions of the Present Day.**—1. Under **Personnel and Features of Man-of-war Life,** and at the end (p. 1021, Vol. IV.) of the text headed "(A) In Peace," it seems desirable to add a few subdivisions under appropriate titles. The various injuries mentioned in the original chapter as incident to and comporting with the new type of ship construction and of the activities of the men perhaps require no comment beyond what is there made. There are, however, other accidents and wounds incident to the varied exposure consequent upon naval service which merit extensive notice.

(*a*) *Wounds of Bites and Stings.*—A reference to the accidents here indicated is suggestive of land operations as opposed to sea-going, but the fact that sailors as well as marines (the soldiers of the navy) are frequently sent ashore in tropical regions on expeditions or for other emergency duty, where they are exposed to the bites and stings of noxious insects, scorpions, tarantulas, centipedes, reptiles, and various animals, brings them reasonably within naval medical concern. The wounds inflicted by predaceous and venomous fish* and other subaquatic life, such as the dogfish, shark, gar, skate, skip-jack, sea-urchin, jelly-fish, and the voracious, carnivorous pike-like fishes inhabiting warm seas, are, however, more particularly identified with seafaring life. Reference is not here made to the results of the toxic properties of fish consumed, but to the wounds caused by some defensive weapon in the nature of a spine. It is fortunate that among the great variety of fishes "only a small percentage are capable of producing deleterious effects upon man, either as poisons when eaten or as producers of poisonous wounds."

* Many fish are armed with spines or needles which can produce serious wounds, the "Pastenaques" especially, whose tail is covered with barbed needles. A great number can be cited which are feared for their bite, but the most interesting to study are those which add to their wounding the inoculation of poison. Among these are those in which poison is connected with the teeth, as in the case of the Murenes, or sea eels, frequently having in addition the needles or spines located in the dorsal region or sometimes in the anal region, rarely in the scapular region. In certain cases the poison sack is closed or enclosed (Synancee, Plotose, Murene); in others it is in communication with the exterior (vives, scorpenes), and these two extreme types are united by different intermediary forms. The poison glands can be compared in a general way to the follicles of the skin, and they are discovered most often in the species in which the skin is smooth rather than among those in which the skin is evenly scaled (vive, perche). The poisonous fish known in the temperate regions and particularly in warm waters belong always to the form having slender bodies and fine and delicate flesh; the presence of venom seems to serve especially for their defence.

The introduction of their poison into the tissues causes a very sharp local condition which rapidly extends to the neighboring regions. Often their wounds are very severe and subjects have been known to become actually delirious and to themselves amputate the wounded part. This state is accompanied by great apprehension, by faintness, and by syncope, sometimes followed by death. The point of inoculation becomes the seat of gangrene of variable extent; one may see suprevene, also, grave phelgmons, with lymphangitis and ganglion block and all the complications of general and fatal septicemia. In point of view of its physiologic action, then, this poison first, locally, kills the tissues attacked; afterward it is absorbed and causes a motor paralysis with hyperesthesia, and at last it seems to retard the heart action, which ends in death.

Among the sea eels equipped with a poisonous palate the blood possesses decidedly toxic properties, and it would be interesting to know if the same is true of other poisonous fish.

Yet such wounds are more common than reports tend to show, and it frequently happens when hauling seine that one or more men receive toxic wounds of considerable gravity.[12] Extensive wounds are sometimes reported, the shark bite recorded in Vol. IV., p. 1020, being a case in point, but they "are, of course, exceedingly rare, and, ordinarily, wounds from fishes are not the result of aggressive action on their part," but from accidental contact, for example, "with the sting ray in its flutterings on the beach or in the net," or from "the handling of fishes with dorsal, ventral, or pectoral spines under which are, at times, poisonous glands. The question includes the action of physiologic toxic serum more or less similar to the venomous secretions of snakes."[12]

The most prominent symptom of these fish wounds is pain, often agonizing and radiating through the afflicted limb. The general symptoms include "muscular inco-ordination, weakness, a feeling of deep anxiety, vomiting, and a slowing of the heart. There is local paralysis of both motor and sensory nerves. Death is not commonly the result of the wound, but it may occur promptly in syncope or later as the result of complicating tetanus or septicemia. Local gangrene is the rule after wounds by the more poisonous species, eschars being thrown off slowly and healing long delayed."[29] The local treatment consists in such rational procedures as early free incision, with cleansing, cupping, and cauterizing, and the general treatment is symptomatic.

(*b*) *Wounds by poisonous weapons* or venomous snakes*, like those by noxious insects, and to which landing parties are subject in certain countries, are matters for discussion in other chapters, and though there are vicious and venomous marine snakes which rarely come ashore, the symptoms and sequelæ following their bite and the treatment differ in no essential particular from the manifestations and treatment observed in bites from those reptiles of better known repute.

(*c*) *Heat Prostration.*—Reflecting upon the comments relative to recruiting, and having in mind the circumstances under which, and the rapidity, even suddenness, with which this condition develops, it may reasonably be regarded as an accident, albeit not clearly surgical. It originates in the vast majority of cases on board ships, and is, therefore, distinctly due to seafaring or naval life. The members of the engineers' force in fire and engine-rooms are those affected, usually under the combined influence of hard work, excessive heat, high humidity, and diminished general movement of the air, though the condition "is apt to be precipitated by sudden change to assisted or forced drafts." As with 90 per cent. of all troubles ascribed to heat it "perhaps has some relation, as a predisposing cause, to nephritis. . . . The hearts and kidneys and stamina of men, if much speed is maintained, are . . . greatly tried, especially if new men, some perhaps not well selected, are working as coal-passers."[12] The fire-room is a very important part of a ship at all times, more particularly during war, and in

* The material used for the purpose may be either mineral, vegetable, or animal.[14] Some savage tribes use the dried venom of snakes;[16] some dip their weapons in putrefying meat or tetanic earth.[29]

view of the strain put upon the men serving there a high degree of physical development is required of applicants for enlistment in the engineer force. It is courting disaster, in the form of heat prostration, and at a critical hour perhaps, to waive departures from such a standard, for though the condition does not greatly threaten life, it is absolutely disabling, often for days.

The large majority of cases on shipboard are characterized by cramps of the muscles of the extremities, back, and abdomen, certain ones even showing such severe recurring contractions as to appear as protruding lumps, and always accompanied by excruciating pain. The cramps may be entirely subjective and of short duration, accompanied by momentary syncope, accelerated pulse, and a sense of oppression. The severer forms manifest more profound constitutional symptoms, such as unconsciousness, subnormal temperature, cold, clammy skin, vomiting, shallow breathing, and a small, soft, and rapid pulse.

In some cases rest and massage will constitute sufficient treatment; in others, active catharsis and stimulants will have to be employed. Rarely morphin will be required to relieve painful cramps.

(*d*) *Asphyxiation.*—This accident, from one cause or another, is of common occurrence, and *drowning* in the navy has led among the causes of death since 1906, about which time, it may be noted, as a contributing factor to this prominence of mortality by submersion, recruiting activities were increased through the inland states. But, in addition to this natural consequnce of what is often "the valor of ignorance" among inland reared youths, as well as of the capsizing of small boats and the collision and sinking of steam launches, of which latter there are two recent incidents on record, there are distinct features of naval service which always embody the menace of asphyxiation; to wit, diving and submarine service; "and on surface craft also men are sometimes overcome in double bottoms or other compartments which have been deprived of their oxygen by paint and other reducing substances." Methods of artificial respiration to be followed in reviving cases due to submersion are sufficiently discussed elsewhere in this work (Vol. V., p. 1013). Suffice it to say that that of Brosch-Sylvester[13a] seems the best, and that before its employment the respiratory passages must be cleared. In practising the above method of resuscitation, Crile's measure of injecting adrenalin centripetally, upon which he lays such stress, can be employed simultaneously.

The "pulmotor" (p. 944) and the Meltzer-Auer method of insufflation of pure air or of oxygen (p. 968) may also be of great use.

With regard to *diving*, the questions of dress, air supply, gas absorption, pressure, and admissible rate of decompression have been so thoroughly studied and developed by both English[7] and Italian[1] investigators that the procedure may well be said to have become a science. "The diver does important work that is frequently performed to meet some emergency, and it is true that the helmet can even be utilized during fires or in bunkers or wherever there may be an accumulation of noxious gases." (The oxygen helmets of the Bureau of Mines should be included

in the ship's equipment for rescue work under such circumstances.) "But of late the required range of diving operations has increased with the possibilities of service at considerable depths, even in relation to submarines." [12] The special investigations by the Diving Committee of the British Admiralty in 1907, and the studies above referred to have made this practicable, but only by the imposition of rigid regulations, including high physical qualification of the diver, which alone forces that particular service under the attention of the medical officer.

The careless neglect or ignorant disregard of the salient requirements will inevitably result in accidents, and, of such as may occur, the ones that can be anticipated are asphyxia from carbon dioxid and "divers' palsy" (caisson disease) in its various forms and degrees from an improper method (too rapid) of decompression.

Submarine craft have reached such a promising stage of development with increased "activity, radius of action, endurance, and secrecy of movement" that no one presumes "to speak in disrespectful terms of the type." Its potential possibilities of valuable service are so discernible that it has taken its place with finality as an important item among the weapons of defense and attack. In the realization of this fact those responsible for the health of the men operating submarines are concerned to see provisions made which will prevent asphyxia and insure a margin of safety even in case of prolonged submergence due to disorder or disablement of the maneuvering gear. This is primarily a problem of naval hygiene, but it bears so directly upon considerations of physical efficiency in war and accidents threatening life that it seems within the legitimate scope of this chapter briefly to touch upon the points involved. These include the initial and reserve air for each man per hour of submergence, the rapidity of excretion and degree of concentration of effete matters, such as CO_2 and the noxious respiratory exhalations, of which latter CO_2 is but an index;* the possible presence of such gases as gasoline, hydrocarbons, carbon monoxid, chlorin, sulphurous acid, sulphuretted hydrogen, or hydrogen itself from storage-batteries; the mechanical removal of the excess of CO_2, which would be found to a great extent in the lower part of the vessel and thus be susceptible of ejection from settling pits; the installation of some form of oxygen-generating apparatus or a supply of compressed oxygen; and the provision for the chemical absorption of the excess of CO_2 and the toxic substances from expiration[3] when vitiated air can no longer be ejected. Finally, it is to be remembered "that whatever air may escape to be replaced by the oxygen is diminishing the 80 per cent. diluent nitrogen, and that any hydrogen which may not have united with chlorin or sulphur to produce poisonous gases may still unite with the increasing oxygen to form possibly explosive compounds."[8] All the foregoing constitutes a complex proposition, the successful theoretic solution of which

* An interesting question is that of the establishment of a danger signal. In the absence of reliability in the olfactory or carbonic acid tests, the only practical guide recommended by Belli and Trocello[3] for submarines consists in a few small mice kept in a cage; whenever these begin to die, they believe the danger also begins for men.

will have to be determined by actual working tests, and it represents one of the many questions associated with special occupations which are being considered. Indeed, the subject of so-called occupational diseases is a widening one in the navy, and all of them bear upon its preparedness and vitality. They are receiving "careful study by naval medical officers, not on economical and humanitarian grounds (as they would interest the physicians in civil life), but on the score of pure military efficiency. . . . The men who manipulate the search-lights must be screened from actinic rays, otherwise their sight is seriously damaged. Ears must be prepared for and protected against the blasts of gun-fire. The continuous use of telescopic sights by gun-pointers frequently leads to serious impairment of vision. It is on these men that we must rely for accuracy of fire. The constructors may give us stable battleships, the ordnance officers high-powered rifles, and the commanding officers may maneuver the ship with consummate skill; still, if the men who point the guns cannot see straight we are not going to have hits, and the outcome of battle may hinge on this remediable defect."[28] The crippling effects of such industrial disabilities must be and are being averted by the studies which Surgeon-general Stokes has instigated, and military efficiency will be by just so much advanced.*

2. In this connection (at the end of paragraph headed **"Medical Department,"** Vol. IV., p. 1021), it seems desirable clearly to reiterate what the aims of the Medical Department should be with regard to the respective requirements of military and humanitarian activities, as so emphatically emphasized in the very recent past.[29] These two considerations cannot be concomitantly respected during battle. The aim should be, absolutely and solely, to further military interests; purely humanitarian endeavors, however desirable they may seem, have no place at this time, and might even lead to additional casualties and possibly the failure of a country's arms. It is not until the close of

* *Submarine Craft.*—Since this was written Cohn[10] has published observations on the effects of submarine cruising on the personnel, with recommendations calculated to improve the habitability of submarines by relieving the contained air of some of the gases, odors, and effluvia which now vitiate it. In this connection he points out that "as far as its power to disable men is concerned, the air at the end of a surface run . . . is more dangerous than the air after a submerged run of similar duration," the difference being attributed to the character of the propelling power used —gasoline engines under the first and electric motors under the second circumstances. He cites a varied array of affections which seem to originate from the conditions or influences incident to this particular service, but lays most emphasis upon the action of gasoline fumes, which appear to be highly toxic, inducing a number of grave symptoms varying in intensity according to "the duration of exposure and the saturation of the air with the fumes," as follows:

"Unconsciousness, varying from temporary loss of consciousness to profound coma; the breathing is slow and shallow; the pulse feeble and thready, often imperceptible; the skin is pale, moist, and cool. In the more severe cases unconsciousness persists for three or four hours. The regaining of consciousness is often attended with convulsions, restraint being frequently necessary to prevent bodily harm. The most characteristic symptom is the intense, splitting, frontal headache, the patient pressing his temples with his clenched fists and usually crying bitterly from the intense pain. Many cases develop severe attacks of vomiting, followed by a peculiar nausea and dizziness, which lasts some hours. In all mild cases the dominant symptom is headache. . . . Repeated attacks of gasoline intoxication predispose to cardiac irritability."

battle that the work of the medical department becomes distinctly humanitarian in character, and it is at this stage that the elaborate plan devised by Stokes, and to be detailed in subsequent pages, becomes operative.

(A) **Provision for the Sick and Injured.**—In supplement to the comments under this heading (Vol. IV., p. 1022), much additional pertinent information could be given. A detailed description of the character and fittings of each space assigned for medical department purposes would be unavailing and the generalization previously given must suffice. It will be sufficient here to mention the extent of accommodation in relation to estimated demands and certain requirements intimately concerned with the practice of surgery.

(*a*) *Extent of Accommodation.*—"In the large ships about 28 beds are provided for the sick, and these suffice to accommodate about 3 per cent. of the total rated complement. Under ordinary circumstances the

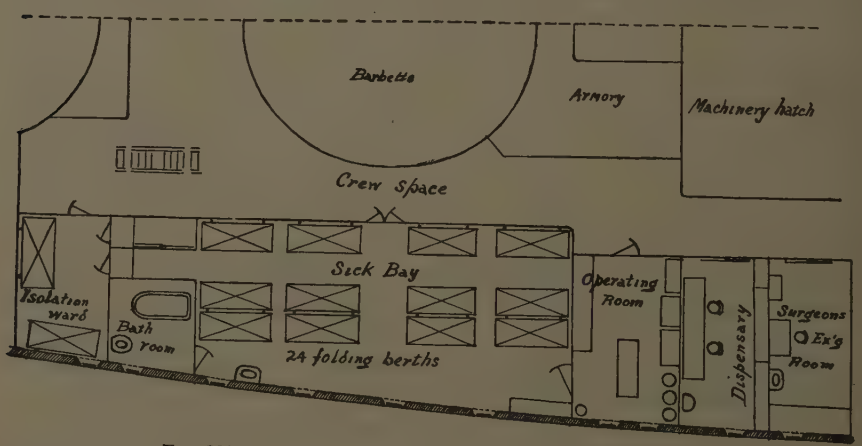

Fig. 361.—New Type of Sick Bay on Board Battleships.

average number of sick on a cruising ship will amount to 1.75 per cent. of the complement. Additional beds are, however, needed over this flat average in order to provide for an increase in the number of sick due to accidents, epidemics, or a lack of opportunity to transfer men to a hospital. Also better discipline is maintained in the sick bay if members of the hospital corps are berthed there and kept from the crew. So, to the beds required for the average sick list, there should be added a marginal provision for unusual conditions and berthing facilities for the hospital corps. On the other hand, cruising ships rarely have a full complement, and there will be some sick on the list who do not require a bed in the sick bay, so that an allowance of beds on the basis of 3 per cent. of the complement should suffice for the needs of the medical department. . . .

(*b*) "*Cubic space* is always limited and adequate artificial means must be provided for the frequent renewal of air. In the absence of such provision cases of shock, hemorrhage, and gas poisoning are deprived of

the oxygen they need, and volatile anesthetics may reach a concentration at which they are explosive and productive of physiologic effects on the operators." [29]

(*c*) The *illumination* which may be relied upon is, of course, entirely artificial, and the conditions aboard ship exact care in the selection of the type of bulb. Certain filaments are so brittle that they will not withstand the concussions and vibrations consequent upon gun-fire and the movement of the engines; others evolve so much heat that they are unsuitable for the small spaces between decks; and still others decrease

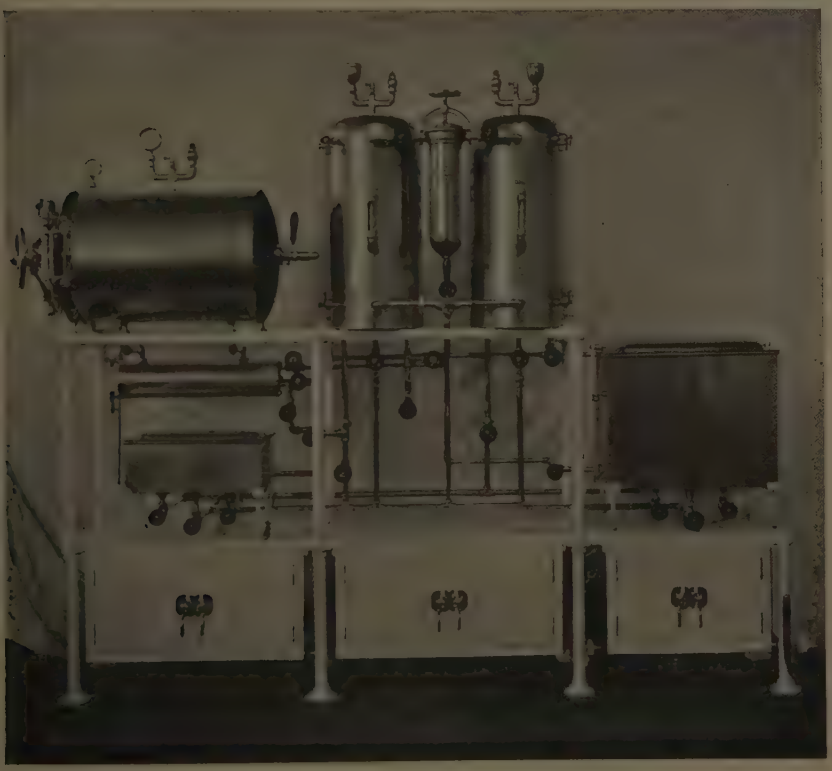

FIG. 362.—"AMERICAN" COMBINATION STERILIZING OUTFIT ON BATTLESHIPS "ARKANSAS" AND "WYOMING," 1910.

markedly in candlepower long before they burn out.[12] On the whole, the Nernst lamp comes nearest to meeting the peculiar requirements, and seems best adapted for use in the ship's operating-room.

In spite of the completeness with which ships are equipped to care for both sick and injured, there are always certain difficulties and "hindrances inseparable from the environment"—incessant noise from machinery and hundreds of men living and working within a small space; the vibration of the ship from its engines; and pitching and rolling at sea—which limit the possibility of satisfactory professional services, particularly diagnosis, and dictate the principle that all cases of a serious nature

should be sent to a hospital or hospital ship, if the transfer can be safely effected. This dictum applies to all cases, whether medical or surgical. The disposition of cases for operation is amply discussed under "Technic" (Vol. IV., p. 1022).

(*d*) With special regard to the *operating departments*, which in ships of the United States Navy are placed adjacent to the sick spaces, it is interesting to note that the Japanese, in one of their newer ships, the "Tsukuba," have adopted the arrangement which seems to have been suggested by experience in the Russian War.[33] In that ship, and may be in others since built, the regular well-equipped operating-room is dissociated from the normal peace-time sick spaces, and placed in an entirely different part of the ship behind the main armor and below the water-line in relation to specially constructed battle quarters for the surgeon, which constitute the principal station in action. This operating-room, inconveniently detached as it may seem to be for peace-time purposes, is nevertheless employed for all major work, minor operations being performed on a portable table in the dispensary of the regular sick-bay on an upper deck. The arrangement of this battle surgery, more complete description of which will be given in subsequent pages, would seem to be a happy solution of a perplexing problem, but it is questioned whether the limited use of such elaborate provisions for surgery during the brief period of an action justifies its permanent establishment in a protected position at the sacrifice of so many features recognized as ideal, if not essential, to surgical practice and success under ordinary circumstances.

(B) **Technic.**—The general surgical "Technic," discussed on p. 1022, Vol. IV., need only be supplemented by the recommendation that, in deference to simplicity, the use of tincture of iodin as a recognized safe method of sterilizing the skin be accepted in substitution for "procedures which involve the tedious application of successive solutions that are difficult to prepare and yet more difficult to store in sufficient quantities."

(C) **Anesthesia.**—Under this heading, to be found on p. 1024, Vol. IV., it is desirable to set down certain modifications and additions, and to emphasize the importance of spinal and local anesthesia and the need that every naval surgeon perfect himself in the technic of the several methods, with stovain and cocain, or one of its substitutes, as the analgesic.

The need of anesthetics in active service in the navy arises in the immediate treatment of the wounded during an engagement; after action either on board the battleships or when the cases have been transferred to a hospital ship; and in their subsequent treatment at a stationary base. On board a hospital ship or at a stationary base the conditions of surgical work are practically the same as in a military or civil hospital in time of peace, and the special difficulties which embarrass the medical officer's endeavors on a battleship during action and immediately after do not have to be faced, save that it is to be expected that there would be an overwhelming number of patients, many pressing for attention at once. "Here the choice of an anesthetic may be made according to the nature

of the case, and local, spinal, or general anesthesia may be employed, as the surgeon may prefer." [13] As intimated above, the range of anesthetics among which selection is possible for use on battleships during and after an engagement is not so broad. For obvious reasons the bulky anesthetics, like nitrous oxid, can have no place, and the volatile, inflammable anesthetics are objectionable, if not actually dangerous—objectionable because of their narcotic effect upon the surgical staff, due to their high concentration in the limited and confined spaces on the lower decks available for medical department activities, and the additional distress consequent upon the odors and noises to which their use exposes the injured, perhaps completely unnerving those who are nearby awaiting their turn at the hands of the surgeon; dangerous because of the igniting character or temperature of certain missiles and the possibility that a chance shell might destroy the electric wiring, when a candle or lantern would be required. Moreover, the medical officer may be suddenly deprived of all ether, chloroform, and ethyl chlorid by the necessity, incident to fire, of throwing inflammables and explosives overboard.[29] If occasion has not demanded this procedure, ethyl chlorid will prove particularly valuable upon the cessation of hostilities in dressing painful wounds, in minor operations, and in such work as the setting of fractures and dislocations, all of which can be done on the spot with great saving of time.[13]

In spite of the objections to local and spinal anesthesia at "the front," enumerated by Spencer,[26] navies seem forced to them by a process of exclusion—a choice between unavoidable evils—and it is believed that from a naval point of view, at least, the objections and limit to their use have been exaggerated (Houghton). Certainly they do not embody the grave objections inherently characteristic of general anesthetics "under conditions of naval warfare when broad considerations may justify the routine adoption of methods which, under normal circumstances, are restricted to special cases."

(*a*) *Terminal anesthesia*, either by direct nerve-block or by Bier's method[4] of injection into the veins (Vol. V., p. 1081), and local anesthesia by infiltration with analgesic solution, are comparatively simple and adapted to the needs of the hour as regards operations. Terminal anesthesia is a means, also, of relieving much agony in mangled wounds,* and, by lessening shock and facilitating transport, affords some hope of successful primary amputation.[34] Wildey, by suggesting a method of insuring the aseptic condition, both of hypodermic needles and of solutions, while at the same time making them quickly available for immediate and repeated use, even under the befouling possibilities and utter confusion attending battle, has contributed an advance in the study to strengthen the medical officer's hand in the amelioration of suffering,

* "The earliest possible relief from pain is a most urgent matter, not only from a humanitarian point of view and for the lessening of shock, but also on account of the demoralizing effect of the severe suffering of the injured upon the minds of the uninjured crew. . . . In such circumstances it is hardly an exaggeration to say that the well-directed hypodermic needle of the surgeon may be a most efficient factor in the fight. Indeed it may be worth a broadside."[34]

the lessening of shock, and the furthering of military efficiency. Briefly, the devices upon which his method of charging a hypodermic syringe with rapidity of action and certainty of dose consist of "(1) an unspillable bottle with protection for its contents under all circumstances" and "(2) a metal scabbard attached to the coat to readily and securely hold the needle-fixed syringe when not in use." To quote further, Wildey says: "Some time ago I contrived a simple and inexpensive shallow glass reservoir to hold not less than 1 ounce of solution, and fitted with two or double-layered India-rubber detachable caps.* Through these caps the needle of the syringe can be thrust into the solution, the syringe rapidly and easily filled—the more rapidly and easily because the needle is steadied by the hold of the rubber. On withdrawing the needle the punctures, of course, close, and if the needle has been entered diagonally the punctures are valvular, thus completely preventing any leakage and allowing the reservoir to be carried in the pocket in any position, or kept suspended by a lanyard. The slight lateral pressure on the needle while charging the syringe prevents the formation of a vacuum." Several different drugs can be kept similarly ready to hand in reservoirs of distinctive shape, and the syringe scabbard could be partly filled with some effective germicide, such as formaldehyd solution, for automatically sterilizing the needle between times of use. The additional necessary adjunct to this simple outfit is an iodin sponge for sterilizing the area of puncture, and with this armament the surgeon is freed from the embarrassments of the exasperatingly petty manipulations usually associated with hypodermic injections.

(*b*) As regards spinal anesthesia, the technic is simple and the results effective for all operations below the costal margin. Stovain as the analgesic in this method has certainly given satisfaction, and can be obtained in sterile solution in sealed glass ampullæ of two sizes, 10 cg. of stovain in 1 c.c. of normal salt solution being used in cases of abdominal section or other high major work, and 5 cg. in 1 c.c. of normal salt solution being sufficient for minor operations.[17] (See Vol. VI., Chap. CLII., p. 981.) It is notable for its utility in cases of exsanguination and shock in which general anesthesia is contraindicated, and this fact alone must commend its employment to naval surgeons, though there are other advantages too numerous to mention, and few, if any, disadvantages which the naval surgeon need stop to consider in the overwhelming demand for his services after battle. The effects of the analgesic soon wear off and it is probable that complete absorption takes place within two hours, so that after that time the possible danger from posture is passed and subsequent transportation to a hospital ship or from a hospital ship to a stationary base is rather facilitated than complicated. The anesthetic effect of victory[6] has been exploited of late, and the exalted condition of men during the height of conflict mentioned

* The perishability of rubber has been taken into account, and, as the rubber caps would be required only in emergencies when the conditions would be strenuous, they should be supplied in hermetically sealed tin boxes, holding six caps, for use in the tropics or when needed elsewhere.

on p. 1047, Vol. IV., is akin to it. Full advantage must be taken of these states and turned to the account of both patient and surgeon in rendering necessary and timely relief.

III. **Organization of the Medical Department and Preparation for Battle.**—1. **First-aid Instruction.**—This feature of preparation for battle, everywhere regarded as important for many years, has now in the United States Navy been given greater prominence than heretofore, and is more thoroughly systematized along lines which insure practical results. It is properly assumed that the surgeon is familiar with the conditions which will require first-aid relief, and that he is capable and industrious in disseminating this knowledge within the compass of his responsibility, directly or indirectly, among those for whose benefit it is primarily intended. It is, moreover, a prerequisite to the best efforts of the medical department that the members of the hospital corps be made proficient by precept and unremitting drill in such duties as nursing, the management of various types of injuries, burns, scalds, and shock, the control of hemorrhage, the application of temporary splints and dressings, the care of postoperative cases, the administration of anesthetics, the performance of artificial respiration, the handling of an injured man with due regard for the requirements of his particular disability, and the different methods of transport applicable in the face of various formidable obstacles likely to be encountered. They must, also, be familiar with the uses of all supplies and articles of equipment and the manner of handling them, particularly those of the surgical outfit which are to be kept sterile.

But it is not enough thus to develop the resources of the hospital corps. The numerical strength of this organization on board every ship is too small to be of any material value in meeting the inevitable excessive demands for first aid beyond a small radius, even if remote parts of the ship could be reached, though the competence of each member of the corps will have a wide influence in sustaining the *morale* of his combatant shipmates. The training above outlined, albeit less comprehensive in character, must be extended to every member of the ship's complement, officers and crew, out of regard for the isolated position of many groups of men in battle and the ministrations they will be called upon to render to wounded comrades. The greatest impediment to carrying out this dictate is an indifferent receptivity to information touching the personal hazards of combat, in part due to the fact that the men "are lacking in any general information which might help them to understand the principle involved," and in part due to a serene confidence in their ability alone to make telling shots, unmindful of the destruction which may be wrought by the enemy. The fact of the matter is, that in spite of efforts to the contrary, neither officers nor men generally could be brought to regard the subject seriously by the old system of instruction, nor was it possible with crews of 800 or 1000 men for the medical officers to be thorough or reach every man when all instruction along this line depended upon them. The combatant elements of the ship's companies must be "made to realize that the enemy is going to be just about as effective as

they" in order that the preparation for probable injuries may be seriously considered, and in furtherance of this idea and to insure the frequently repeated rehearsal of first-aid procedures for the benefit of every man, the instruction should be conducted by the line officers in association with the weapons of offense—a part of every drill with guns, great or small.[24] In pursuance of this logical conception Surgeon-general Stokes has recently secured the promulgation of a general order establishing such a system, the obligation now devolving upon medical officers being to instruct division officers, and the scope of instruction, while not strictly limited, being to prepare the officers to instruct the enlisted men primarily in the following specified subjects: (*a*) Control of hemorrhage; (*b*) application of occlusive dressings; (*c*) resuscitation of the apparently drowned. In teaching to control hemorrhage stress must be laid upon methods other than the tourniquet, since this is rarely necessary and its irrational use or neglect after application is attended by more harm than good. The correct application of the dressing contained in both the first-aid and shell-wound packets is simple, but every man should be given careful training in handling them, for his own or a comrade's life may depend upon such knowledge. The shell-wound dressings can be improvised and sterilized on board ships, and a number of "dummy" dressings should be kept on hand for use by the several divisions in their first-aid drills.

2. **Statistical Considerations.**—The all-big-gun ship, which marks the latest widely accepted advance in naval architecture since Vol. IV. of this work was published, although the tendency was observed at that time, and the 12- and 14-inch rifles promise to assume an exclusively important rôle in naval warfare. The extreme protection provided at the positions of these guns and the opportunity of placing the unengaged part of the crew under cover and behind armor elsewhere or below the water-line, and the great range, 10,000 to 12,500 yards, at which firing will begin, with all that that entails in misses and decreased effectiveness, suggest that the future may modify past statistics.

3. **Posts for the Wounded.**—The first and most important change to be made in this section, found on p. 1028, Vol. IV., is the manner of characterizing the principal dressing stations, which are to be known as secondary stations, not primary stations, as originally stated. This change is indicated for the purpose of harmonizing the names of our stations with the more recent ideas and for the reasons presented in the following paragraph:

"In describing our dressing stations we shall be guided largely by a scheme which is capable of being applied to shore conditions without material alteration. The reasons why the constitution and equipment of naval forces should so far as possible conform to those of the military forces of a nation, have their basis in the frequency of landing parties. When a landing party is thrown on shore without warning the excitement and disorder which follow do not favor the successful operation of a strange system suddenly put into practice under novel surroundings. We shall escape much confusion if our familiar system can be landed with

us, for it will be readily granted that in any stress a system is less likely to break down the more automatic has become the practice of its principles. In the event of war the number of new enlisted men may be in excess of trained men, and, at best, there may be neither time nor opportunity for adequate drilling to insure the mastery of a system of first aid adapted only to naval employment. This difficulty is not lessened if teaching another system for landing parties be attempted. Moreover, in combined operations with the army, harmony of action, transportation of supplies, and replacement of equipment are greatly facilitated by the suggested uniformity, which should be extended to embrace details of organization, equipment, and perhaps even nomenclature." [29]

(A) Therefore, primary stations are to be designated secondary stations, and *vice versâ*, in the arrangements aboard ships, and in conformity with the above expressed desire for uniformity the parallelism of naval and military schemes for the care of the wounded is tabulated below:

Military.	Naval.	
Base hospital	Sanitary base. / Hospital ship.	
Stationary or evacuation hospital	Secondary station.	On board the battleship.
Field hospital (collecting station for slightly wounded)	Primary station.	
Field dressing station	Relief station.	
Regimental aid	Relief parties.	

(B) With respect to the secondary station (principal station), the hope was expressed on p. 1029, Vol. IV., that naval architects might give some heed to the requirements of its dual function. This hope has

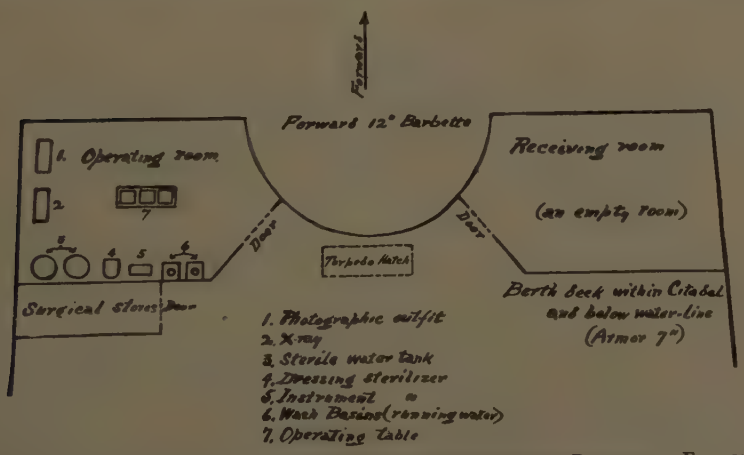

FIG. 363.—DIAGRAM OF "TSUKUBA'S" PROTECTED SICK SPACES AND POSITION OF FITTINGS.

now, to a greater or less extent, been realized. As mentioned under "Provisions for the Sick and Injured," the Japanese on at least one ship have detached the operating-room from the sick-bay and placed it in the battle quarters. On the "Tsukuba," as shown by the accompanying

diagram, "two large compartments, situated on either side of the forward 12-inch barbette on the berth deck, are designed for the principal dressing stations. The position is behind the main armor and below the water-line. They are symmetrically arranged and of equal size. The port compartment is the main operating-room of the ship and is permanent. It is 20 by 18 feet in size, has a tiled deck, and the bulkheads are smooth. Plain incandescent lamps are in sufficient number to give good light." The equipment is complete and well arranged. Just abaft "the operating-room, but not connected with it, there is a large storeroom for medical supplies," which location, while affording desired

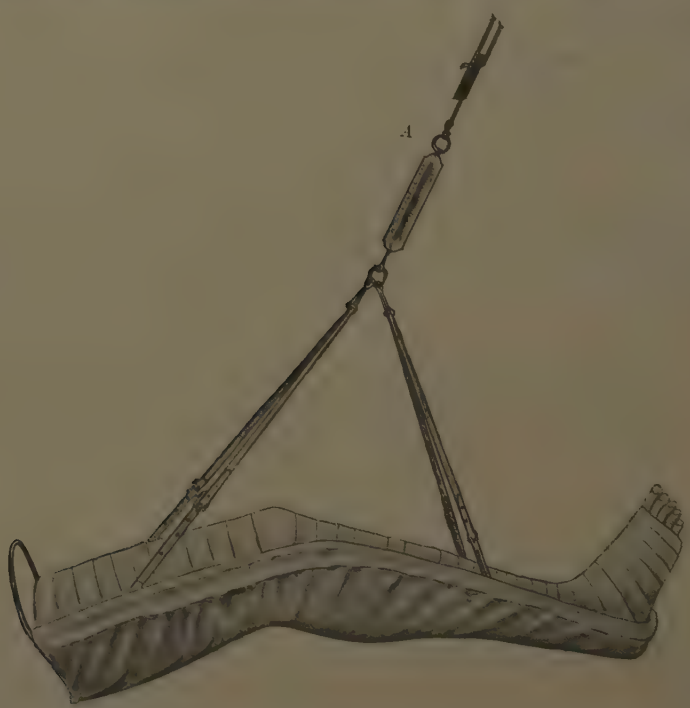

FIG. 364.—HODGEN SPLINT.
Note that the suspending cord *A* is not vertical, but makes traction on the thigh.

protection, makes them quickly accessible. "The starboard compartment is a bare tiled-deck room designated (for use in time of war) as a safe resting-place for the wounded who have been dressed while the action continues."

"Between the two compartments is a large hatch running up through the gun and main decks, which, according to plans, is to be used as a direct communication in transporting the wounded."[33] Such an arrangement has this advantage, in addition to the more obvious one, that owing to the fact that the operating-room in peace is the operating-room in war, the habit of transporting the injured or those otherwise requiring

surgical attention to one specified place not only need not be changed, but would actually constitute a guarantee against confusion in the disposition of the wounded during action.

In the ships of the United States Navy definite deck compartments within the citadel and below the water-line, or beneath the splinter deck, are now designated as battle quarters for the medical department, and equipped with all the fixtures necessary to a dressing station, so arranged as not to interfere with the employment of the compartments as storerooms or crew spaces in time of peace, but also so as to permit an expeditious transformation and adaptation to medical department purposes.

The adjoining spaces and passageways or an adjacent storeroom would afford a resting-place for the wounded after they had been dressed. The equipment includes:

1. A metal action dressing locker of ample dimensions, provided with three shelves.

2. A hopper with both hot and cold

Fig. 365.—Modified Cabot Posterior Wire Splint.

Fig. 366.—Cabot Wire Splint in Use.

fresh water, the capacity of the tank from which the cold fresh water is supplied to be sufficient to provide at least 1 gallon for each man wounded, allowing for 20 per cent. of wounded.

3. A rack which will hold four bottles of 5 pints' capacity each.

4. At some point over the area to be devoted to operating purposes three ceiling hooks from which to suspend irrigators, etc.

5. Four to six metal shelves, 2 feet deep and 5 feet long, with all edges upturned; outer edge supported by chains; inner edge hinged, so that the shelves can be folded up against bulkheads when not in use. These are to hold dressings and are to be disposed on the bulkheads in the berthing section of the battle dressing station.

6. Two shelves in the operating section of the station to hold restoratives, materials for anesthesia, instruments, apparatus, and dressings, etc.

7. Steam connections for installing the instrument sterilizer corresponding to those in the regular operating-room with cut-off valves. Steam connection for a water sterilizer might be desirable.

8. Provision for additional illumination. Each 36 square feet of space devoted to operating purposes to have one cargo light of six lamps each or its equivalent.

9. Two circuits connecting the lighting bulbs with the electric generating plant.

10. Extra sockets available for electric-fan connections.

11. Lanterns for emergency use.

12. Ventilation must, of course, be satisfactory, and it would be well if mosaic or tiled or other form of easily sterilizable deck could be

FIG. 367.—BLANKET SPLINT BEING ROLLED. (From U. S. Naval Medical Bulletin, Vol. V., No. 1.)

provided. Positions should also be marked off for the stowage of medicine chests, field-chests, instrument chests, *x*-ray apparatus, and operating-tables, etc.

The idea of all this is that in these arrangements the medical department is provided with protected and partially equipped and definitely

FIG. 368.—BLANKET SPLINT BEING APPLIED. (From U. S. Naval Medical Bulletin, Vol. V., No. 1.)

located emergency surgeries, with which familiarity can be bred by repeated drills, and in which the medical department of ships can quickly establish principal stations in anticipation of hostilities. It does not mean the allotment of increased space to the medical department. The regular peace-time sick spaces, including operating-room, are to be continued in the more or less favorable situation in which they are now

placed, and the surgical equipment and other valuable medical department supplies are to be transferred to the provisional stations only in preparation for war. At this time, also, should additional storage space be required by the executive officer or paymaster in lieu of the storerooms turned over to the medical department or for other cause, the ship's stores, consisting of such articles as are not of vital importance immediately after battle, could be transferred to the sick-bay, although this is to be avoided if possible, owing to the legitimate use to which the sick-bay may be put after engagement.

It is probable that on some ships one of the primary stations would be merged with this secondary station, and provision thus made for both safe storage and active work in a single protected locality.

Notwithstanding the provision of these more or less completely equipped protected stations, as on the " Tsukuba," for instance, devised as places for the retreat and succor of the wounded as well as for safeguarding the surgeon's division and supplies, the scope of relief consid-

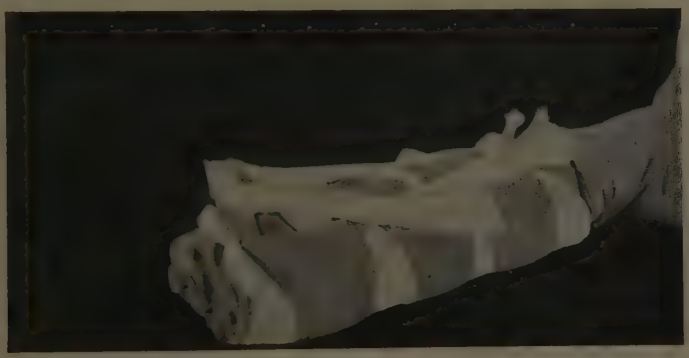

FIG. 369.—BLANKET SPLINT, APPLICATION COMPLETED. (From U. S. Naval Medical Bulletin, Vol. V., No. 1.)

ered possible during active hostilities is, in the opinion of some students of the subject, undergoing considerable modification. Small as the opportunity for the employment of relief measures has been regarded in the past, it is now held to be so limited as to even justify grave doubts that any elaborate provision should be made for active surgical work at the protected and consequently more or less difficultly reached localities of primary and secondary stations. These, it seems to be believed, should be characterized as "distributing stations " and fulfil five specific functions: (1) Places of relative security for the medical staff during action; (2) the conservation of medical stores; (3) the preparation of first-aid dressings for replenishments; (4) the distribution of dressings, etc; (5) the treatment of anyone slightly wounded who can gain access to them of his own accord.

4. **Disposition, Arrangements, Supplies, Etc.**—Large collections of wounded at these stations are advised against as hazardous and without commensurate benefit. The wounded will have to be simply lifted aside out of the way to the most protected place at hand after first aid has

been rendered. "It is not intended, if it can possibly be avoided, to move wounded men below, as the moving of them and the vitiated atmosphere that would obtain there would be sure to have a deleterious effect. The medical stores are made as portable as possible with a view to their removal to any position selected after action for the treatment of the wounded. Such positions must, of course, depend upon the condition of the ship after action, but some portion of the upper deck screened off would probably be found to be the most suitable place. There only dressings and operations of urgency would be undertaken, and

Fig. 370.—Spear's Shell-wound Dressing.

the wounded would then be removed to a hospital ship for further treatment, or to an ambulance ship for passage to a naval hospital." Such is the trend of opinion, and the logical correlary of this idea is found in the after-battle scheme and provision devised by Surgeon-general Stokes, to be outlined in subsequent pages.

(A) To the medical and surgical supplies enumerated on p. 1031, Vol. IV., may be added such valuable surgical devices as Hodgen and Cabot splints, shown in the accompanying cuts; the blanket splint, as an ingenious example of improvision; sand-bags for splinting; rubber

operating gloves; and tincture of iodin and Harrington's solution to take the place of the bulkier disinfectants for sterilizing the skin.

(B) Under "First-aid Dressing," p. 1033, Vol. IV., Spear's shell-wound packet deserves to be mentioned. It "embodies a coaptation splint of wood" and "is described as being capable of repeated sterilization by either steam or solutions. It supports a single member and attaches it to the trunk or opposite member, is quickly applied, and is applicable to all sites." [29]

In further preparation for battle and with a view to minimizing the damage suffered, certain prophylactic measures in addition to those already described in Vol. IV. (such as first-aid dressings, the bath, aseptic undergarments, boric acid eye-wash, cushioned shoes, and ear protection) may be put into practice.

(C) "Supplies of drinking-water ought to be placed in convenient localities. The extreme thirst accompanying hemorrhage and shock is familiar, and, when further intensified by the smoke and acrid fumes of gun-fire, it is rightly described as torture, for which we should not fail to provide relief. Cold water serves another useful purpose. It is a most effective stimulant to wearied men, invigorating their bodies and sharpening their dulled faculties."

(D) *Some Measures of Prophylaxis Against the Consequences of Abdominal Wounds.*—"Action having been taken to make the skin as clean as may be (by the prescribed bath and clean clothes just before an engagement), the excessive mortality of abdominal wounds and the futility of operation prompt us to attempt some measure calculated to render the intestinal contents innocuous. Naturally, the wholly successful methods familiar in gastro-intestinal surgery are not practicable, but nevertheless some real lessening of intestinal toxicity may be brought about by such simple measures as we can employ. The amount and variety of intestinal flora can be greatly diminished by a diet which can be and is completely absorbed. Not only are the results of abdominal wounds mitigated when the intestine is empty and comparatively free from organisms, but the course of wounds other than abdominal is favorably influenced when the intestines are not loaded with putrescent material and the body is not surfeited with food. It may, then, be worth while to restrict diet before battle, so that digestion may be perfect, absorption complete, and assimilation not beyond physiologic needs.* A mild cathartic is a further means to this end." [29]

FIG. 371.—ELLIOTT EAR PROTECTOR IN POSITION.

(E) With reference to the protection of the ears from possible damage due to the rapid alternation of positive and negative pressure succeeding the discharge of heavy ordnance, it is desired to qualify the advice pre-

* The navy ration is particularly liberal, and considerable reduction can be allowed without encroaching upon physiologic needs.

viously given relative to the open-mouth feature of expectancy and to emphasize the observation that "the nervous mechanism of the internal ear is the part most commonly damaged." Bone conduction and the sudden, violent motion of the middle-ear ossicles may both cause such extreme vibration of the endolymph and perilymph as seriously to affect the auditory nerve terminals, but with the external auditory canal blocked, the Eustachian tube is the most direct channel to the labyrinth and irreparable deafness. Moreover, it is very probable that the positive pressure wave would not reach the internal and external surfaces of the drum simultaneously, and that the effect of each might be supplemented by the influence of a negative wave on the opposite side, thus doubling the movement of the ossicles and the danger of rupture. If this is true, as seems likely from instances recorded by the Germans, the open-mouth expedient to equalize pressure not only fails of its purpose, but is attended by added risk.

Mere suspension of function and partial deafness, pain, tinnitus, and headache are the usual consequences of gun-firing, but these symptoms are often ignored as trifling unless accompanied by hemorrhage. As it is a plain duty to take precaution against the vulnerating power of the blast, so, also, it is well to investigate all cases with the above symptoms and take prompt precautions against infection and otitis.

IV. **Conduct of the Medical Department During Battle.**—1. **Scope of Relief.**—From what has been said on preceding pages relative to the scope of medical department activities now being considered possible, it will be seen that greatest reliance in the care of the *accessible* wounded must be placed upon the relief parties; yet the disposition of the surgeon's division, in deference to the need of hospital apprentices at the secondary and primary dressing stations, and in deference, also, to the requirement that as many as possible of the surgeon's division be safeguarded against the hour when it is possible that they may be of supreme usefulness, reduces the number of such men available for relief station work to the point of inadequacy, and leads the medical department to turn to other branches of the service for assistance in carrying out its scheme. It is generally estimated that a number equal to 5 per cent. of the ship's complement are necessary for this non-combatant service—a definite, constant number of men trained and drilled for the purpose. To obtain such a " relief corps "[32] from this source in the undermanned condition of navy ships to-day, when every available man, as laid down in the complement, is needed " to carry on the actual fighting processes, namely, manning the guns, providing ammunition, developing the motive power, directing and controlling the ship's movements, etc., is simply impossible." The apparent conflict of interests forces a compromise, and in accepting a third of the above estimate some compensation is to be found in the now more and more clearly recognized restricted scope of even relief work in sea engagements, to say nothing of more elaborate surgical procedure. Indeed, so restricted has relief work come to be regarded that some are advocating the abolishment of so-called " relief stations " as such, and making the divisions of the relief corps ambula-

tory parties, keeping under cover within the zone of protection as far as their duties will permit, to minimize the casualties among their members and rendering services wherever and whenever the need develops.

2. In many, if not most, instances the **disposition of wounded companions** would devolve upon the gun's crew, which should give such first aid as indicated and lay them to one side out of the way until the engagement is ended. With this point in mind, opportunity is taken to emphasize the importance of placing a liberal allowance of shell-wound packet in canvas or metal containers convenient to the different divisions of the ship's complement. This suggested comparative passivity of the medical department during battle is not explainable as an absence of solicitude for those suffering the distress of wounds, nor a lack of confidence "in the results of surgical interference under the conditions imposed by battle." It is entirely in obedience to the dictate that no element of the ship's organization shall be allowed to constitute itself a hindrance, but rather that each must contribute its quota toward the perfection and ultimate success of naval action at the expense of humanitarian considerations if needs be. There is no need to dwell upon the increasing difficulties which the present tendency of battleship construction is placing in the way of physical communication between different parts of a ship—a tendency entailing far-reaching consequences in respect to the required and possible activity of the medical department. If transportation of the injured cannot be effected save by opening hatches and water-tight doors, etc., the injured must remain where they have fallen and continue with fortitude to serve "their ship, fleet, and country" in the face of restraints which, "guided by the principle of the greatest good for the greatest number," must be maintained in the interest of the ship's safety. A review of the available statistics teaches that half of the estimated probable casualties (20 or 30 per cent.) would immediately or soon after terminate fatally, even if promptly reached by surgical relief; while the balance could either return to their posts, reach the dressing stations without assistance, or safely await the opportunity for transport to the dressing station during a lull in or after the engagement. Disturbing as a situation of enforced inaction is to the individual at such a trying time, it must not be permitted to occasion concern for the possibly wounded—nor need there be too great fear that the proximity of the disabled, injured and dead, whose removal, though desirable, cannot be effected, will undermine the *morale*. There are recorded opinions and instances in support of the contention both for removal* and for non-interference,† but it is not imperative, indeed, it is idle to attempt

* "An instance indicating this need" occurred, it is said, during a naval action in the Russo-Japanese War. In this case the shrieks of a wounded man—his thigh pinned by jagged iron plating in a fighting top of a cruiser—most seriously distracted, if they did not actually demoralize, the guns' crews on the upper deck.[34]

† History abounds in narrative which depicts the crews of ships fighting on deluged in blood and surrounded—their movements impeded even—by the dead and seriously wounded. This is not fiction, yet such oblivion to shocking conditions is more apt to be the accompaniment of confidence in victory. While the defeated men are full of imaginary terrors and subject to panic, the conquerors are intoxicated with success.[6]

to settle the theoretic right or wrong of the question. The revolution in construction has largely decided the question, effectually tying the hands of the medical department during battle, and, while realizing that fact, there should be encouragement in the thought that not only are the wounded quite as comfortable and protected from further injury where they have fallen as would be the case at a dressing station, but they are also safe from the dangers and torments incident to abandonment and neglect for hours and even days as in the case of the wounded on a battlefield. The wounded on board ship are " in reasonably clean surroundings and in a tolerable temperature," and the hour when all can be gathered in and given the attention their varied injuries demand will, in all probability, not be long postponed.

(A) In connection with these modified views concerning the disposition of the wounded during action, it is pertinent to refer to the question of the disposal of the dead. A reversal of the dictum expressed on p. 1041, Vol. IV., is unavoidable, as " our responsibility for a man does not cease with his death; we must care for his body, when possible, and forward a report of his death, so that both the department and the man's family may have authentic information concerning his fate."[29] Though hospital ships embody accommodations for a certain number of dead and embalming is possible on board ship,[25] the vast majority would probably have to be buried at sea. The important matter is identification, and for this purpose a light metal tag, bearing the full name and rate or a registered number, is most conveniently and securely attached to the person by suspending it from the neck. This expedient seems absolutely necessary, for it is frequently difficult to recognize the dead for one reason or another, and " under certain circumstances it may be impossible to say who are dead and who have escaped to other ships or been captured by the enemy."

3. **Conclusion.**—It must be apparent from what has already been said that the organization of the medical department for battle along the line of secondary, primary, and relief stations, etc., is becoming obsolete. The scheme is to a certain extent and on certain ships inapplicable to-day, but it should still be studied as a guiding principle, and its practical employment is possible on some ships still in commission. For these reasons the space devoted to the detailed description of the scheme which has received almost unqualified sanction in the past is by no means wasted. The changes in construction, armament, and tactical maneuvers, as they influence the probable number of wounded and the methods of their management, are constantly making it a new, interesting, and ever-urgent subject. This existing state of transition in the process of evolution which has been above noted, however, exacts additional space in the detailed description of those plans which seek to compensate the imposed inaction during battle and to perfect the after-battle provisions. These will be taken up later, but before doing so it seems necessary for purposes of clearness and completeness to make a number of additions to the discussion in Vol. IV. under—

V. **Surgical Conditions of Naval Warfare.**—1. **Regional Wounds.**—(A) *Wounds of the Extremities.*—With further regard to treatment in these cases during action on board ship it should be said that "injuries short of ablation should be treated with the one idea of saving all the tissue possible." The question of selecting that particular operation which will conserve the greatest degree of function must be deferred until a less pressing time and a more suitable place "when the wound is healed and interference may be adventured with good assurance of the ultimate results to be attained."

(B) *Wounds in the Lower Half of the Body.*—With further regard to treatment in these cases and in view of a very proper hesitancy to undertake laparotomies, except in such an urgent condition as threatens exsanguination, and in view, moreover, of the imminence of peritonitis

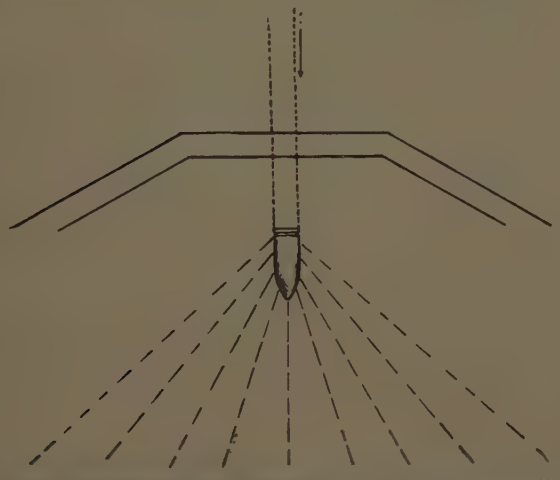

FIG. 372.—DIAGRAM ILLUSTRATING THE EFFECTS OF A BURSTING SHELL. (After Stokes.)
When a shell explodes the disruptive action of the powder is so modified by the onward momentum of the mass that the area of damage from the fragments forms a cone, with its apex coinciding with the point occupied by the shell at the instant of disruption.

in all abdominal injuries involving a viscus, attention is directed to the Ochsner and Murphy treatment of peritonitis as offering the only hope.

2. **Injuries to Blood-vessels and Nerves.**—These structures do not frequently escape participation in the lacerated and contused wounds inflicted by shell fragments, although the usual crushing and searing character of such wounds closes the blood-vessels and prevents serious primary hemorrhage. If these structures are not actually severed or segments carried away or imperiled by a spreading infection, their integrity suffers from a coagulation necrosis of the surrounding tissues consequent upon the devitalizing influence of the vulnerating missile, and "physiologic severance of nerves and late aneurysms" may supervene. The frequency of traumatic aneurysms was observed by the Japanese, and are often susceptible of cure by the Matas method, though no rule of procedure can be laid down, the technic being decided

upon as indicated in each case. The same is true of an injured nerve. Simple suture of cut nerves should be performed *early*, and recourse may be necessary to resection, transplantation, or implantation.[16]

3. **Scalds and Burns.**—The additional elements of treatment regarded as of value in cases suffering these injuries, and not mentioned in Vol. IV., are saline enemata and skin-grafts. In all cases where shock is pronounced, saline enemas, with or without adrenalin, administered very slowly every three hours, are said to be of great benefit. Nutrient material in the shape of liquid peptonoids may also be added to the saline solution above mentioned, if necessary. Skin-grafts grow surprisingly well on suppurating, granulating surfaces, and it is, therefore, unnecessary to wait until the wound is absolutely clean for this procedure.[9] Indeed, it is believed that primary grafting should be resorted to more often than is customary.

Although the treatment is the same for the devitalization of tissues due to excessive heat, the character of burns and scalds are dissimilar, and they are also of different origin—one being due to an intense dry heat or flame, usually of short duration, as in the case of the explosion of smokeless powder; the other to intense moist heat of short duration. Members of the engineers' force are especially exposed to terrible scalds, bursting pipes and valves permitting the sudden escape of large volumes of steam under high pressure into small compartments at the bottom of the ship from which a hasty exit is impossible.

"As a part of first-aid instruction men should be warned that escape from the compartment is not to be thought of. The vapor tends to rise, and hence let them be taught to lay hold of some covering, throw themselves flat on the deck, face down, shut their eyes, hold their breath, and wait. The time will not be long, for condensation will be completed in a few moments at most."[29]

4. **Special Conditions and Constitutional Effects.**—(A) The subject of irrespirable gases, little more than mentioned on p. 1057, Vol. IV., merits further consideration in view of the rôle which the toxic action of these gases has already played in warfare, and is likely to play in the future. Arising both from the discharge of guns and the bursting of an enemy's shells, a ship is usually enveloped by the fumes of some kind of explosive, which may be sucked in and distributed to all compartments by the ventilating system, or penetrate to different parts of a ship in the vicinity of the explosion. Even if the blowers could be stopped for a prolonged period the enveloping gases would reach the interior by diffusion, or the direction of the wind might carry them through hatches and accidental openings. Hand grenades containing chemicals productive of poisonous gases have been used by forces in land operations, and their employment, together with bombs, may find a place in naval warfare if the aëroplane, as seems not impossible, becomes an available offensive weapon at sea. In any event, and without the need of bombs and hand grenades, the already existing prolific sources of noxious gases suggest the advisability of some provision for quickly renewing the air of a compartment when occasion requires,

such, for example, as a large supply of fresh air stored under pressure and awaiting release through pipes into one or another of the separate compartments. The gases evolved in the burning of smokeless powder and other high explosives are not accurately known, and have been variously stated according to the constitutent elements of the compound and the rate of combustion. The characteristic symptoms developing upon exposure to these gases have been given in detail by Keiffer, and from his observations during a series of experiments it seems best to supplement the symptoms briefly sketched on p. 1057, Vol. IV., as follows: The pulse becomes rapid, arhythmic, and dicrotic; there is a decided fall in the blood-pressure, angor cordis, thoracic distress, a sense of oppression, violent headache, smarting of eyes, and dryness of throat; and there are disturbances in the nervous system. Of all the symptoms, those dependent upon the grave chemical changes in the blood which result in the formation of methemoglobin seem the most important to emphasize as indicating a hopeful line of treatment—the direct transfusion of blood. In this, as in other respects, the treatment of these cases is quite similar to that for poisoning by illuminating gas.

(B) Among special conditions and constitutional effects consequent upon the circumstances of warfare, mental and nervous diseases have been shown[17] to have contributed an important percentage to the disabled. This was so in the Russo-Japanese War; it promises to be even more so in future wars, for "the tremendous endurance, bodily and mental, required, . . . and the mysterious and widely destructive effects of modern (heavy gun) fire will test men as they have never been tested before."

The variety of psychoses which may develop under the stimulus mentioned seem apparently numberless, ranging from pure hysteria to the gravest form of functional derangement, and their immediate exciting cause is equally varied, depending in different cases upon the confusion and terror of battle, or the excitement immediately following; upon prolonged exertion, deprivation, loss of sleep, hunger, or thirst; upon certain intoxications, and upon psychic trauma, etc.[29] Arising as these mental conditions do, perhaps, in some instances "on the basis of a special neuropathic constitution," under the influence furnished by the circumstances of war, they all display a depressive character and constitute a serious charge upon the hands of the medical department. The greater portion of the mild derangements clear up in a few days, though mental instability shows itself in various ways for several weeks, so that for the time being, as far as concerns their dependence and need of supervision, they are as great a loss to the fighting arm as the more permanent psychoses.

VI. **Conduct of the Medical Department After Battle.**—1. **Dressing Station.**—If circumstances incident to the destruction produced by gun-fire do not indicate the desirability or actual necessity of remaining at one of the battle stations, it is now time to seek a new station, away from the heat and foul air of the 'tween-deck protected localities which

were deemed of paramount importance during battle, at a more accessible, unencumbered, roomy, well-ventilated and well-lighted situation, to which all, or at least the more seriously wounded, can be congregated and given required attention until their transportation to ambulance or hospital ships can be effected. It may be, as stated on p. 1062, Vol. IV., that the regular sick-bay has escaped being gutted and can be utilized as the after-battle hospital, in which case the task is simplified; but in any event the new station, whatever locality may be selected for its establishment, becomes the center of medical department activities, and hence all supplies for the care of the injured must also be assembled there. The work of gathering in the wounded and collecting equipment should proceed simultaneously in order that valuable time may not be lost. All other duties connected with this period of service should be apportioned between sections of the surgeon's division, if staff and equipment permit, and carried on with system and celerity; with discretion as to the relative urgency of cases; and with a view to giving adequate attention to the greatest number in preparation for their transfer. The allotment of duties among the personnel of the surgeon's division must be made with this end in view, but will depend upon their number, the character of their several capabilities, and the possible division of the available space. Some capital operations will have to be performed, but in this the surgeon must be guided by the principle that only the least that will suffice to save life should be undertaken, and in the main his work here continues within the field of first aid, albeit possibly of a more thorough-going character.

2. It will be found that in some cases—those who have been reached by members of the relief parties—**diagnosis** or **dressing tags** have been attached to the primary dressing, but now it becomes a duty of great moment to see that all wounded are carefully tagged, giving full information as to the date and time of dressing, the name and rank or rate of the individual, the name of ship, the character of the wound, the nature of the treatment already given, the urgency and nature of required further attention, and the transportation which may be undertaken. From these, with the aid of the identification tags on the dead or unconscious, accurate records can be obtained for report to the commanding officer.

3. The **dead** are to be collected and placed in some compartment set aside for the purpose until they can be identified and properly disposed of, either by transfer or burial at sea. This duty of quietly transporting the dead to an improvised morgue on the ship should be performed by a special detail made up of men from divisions other than the surgeon's division. It is, however, important that a medical officer determine which of the injured are actually dead before disposition is made of them, but aside from this duty the entire number of medical officers and hospital corpsmen is required to engage in the more important work of caring for the living, whose needs do not end with the completion of an operation or the application of a dressing. The wounded must be berthed, fed, nursed, carefully watched so that serious complications may not develop unnoticed, and given the sanitary attention which the

excretory functions of the body demand. Finally, the hygiene of the sick spaces and the sanitation of the ship as a whole must be given as thorough attention as the wreckage will permit, with a view to preventing the spread of infection, such as gangrene and erysipelas, and the stench of decomposing tissue. Soiled dressings must be promptly disposed of and flesh and blood washed away and the decks disinfected. The duration of the period of this after-battle service on ships of the line will be greatly curtailed, and all the imperative needs (humanitarian and military) of the situation will be more efficiently met by the operation of the scheme now to be described.

4. **Scheme for Caring for and Clearing Ships of Wounded After Battle.**—With a view to understanding the immensity of the problem which this plan seeks to solve, it must be observed in passing that if the battle organization be 16 ships, with a complement of approximately 1000 men each, and if of these 16,000 men engaged, 20 per cent. is a reasonable expectation of casualties, it is clear that provision must be made " for the care of 4000 to 5000 killed and wounded of our own and possibly as many more of the enemy." There must be some means of expeditiously removing from the fighting ships these scattered and maimed thousands of fighting men (" the success of the fleet " in resumed hostilities " may depend upon this very maneuver "), and giving them the continuous treatment and other care at the hands of the same group of skilled surgeons " which their great sacrifice merits . . . until they are finally disposed of at the sanitary base."

(A) *Elements of Scheme.*—The plan which has been devised in answer to this manifest need depends upon: First, the authorization of a Naval Medical Reserve Corps, composed of men of the highest professional attainments; second, the commissioning of four " sanitary ships," each capable of carrying 1000 wounded, for a fleet of 16 battleships—one sanitary ship for each division of the fleet; and, third, the establishment of a great medical base, either on the Pacific or the Atlantic seaboard, in a locality offering the facilities for the necessary features of such a base and at a point most easily reached from the probable field of operations. Again, it might be necessary and possible to establish such a base either in Pacific waters, as at Honolulu, or in Atlantic waters, as at Guantanamo.

The first of these three requirements must be authorized and organized as a standing preparation, for without it the proposed scheme would not be feasible. The other two requirements are purely war measures, to be provided for in the immediate anticipation of hostilities, and it should be understood "that, under the articles of the Geneva Convention and Hague Conference, the necessary ships may be procured anywhere, may coal and provision in any port, being neutralized under the Red Cross, and are, consequently, not likely to be an encumbrance to the fighting forces " or complicate its coal problem. The medical base cannot be represented by civil hospitals in the several cities in the neighborhood of what might be regarded as a proper situation, for it is inadvisable to scatter the wounded here and there, nor would the civil hos-

pitals be prepared to take care of them, and "only one naval hospital of the United States has a suitable environment and is so located that it could be utilized as the heart of a great sanitary base." It is probable that a large hotel for administrative purposes and for the accommodation of the wounded, with its grounds for expansion under canvas, could be found to meet this need.

(B) *Working of Scheme.*—Now as to the scheme of action based upon these humanitarian provisions. "Briefly stated, the plan is as follows: Four ships, capable of caring for 1000 wounded each, will be required for 16 battleships. Each of these ships will carry a few necessary regular medical officers, and, in addition, there will be one regular medical

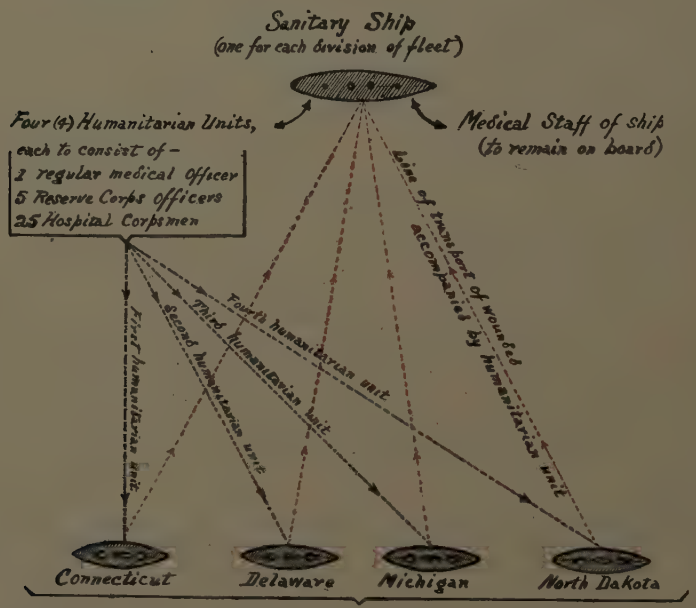

FIG. 373.—SCHEME OF AFTER-BATTLE RELIEF, ONE HUMANITARIAN UNIT WITH SUPPLIES TO BE TRANSFERRED TO EACH SHIP OF THE DIVISION AT THE END OF AN ENGAGEMENT TO CARE FOR THE WOUNDED AND TRANSPORT THEM TO THE SANITARY SHIP AND TO THE SANITARY BASE.

officer for each ship of the battle fleet, and under him at least 5 medical reserve corps officers and 25 hospital corpsmen, representing the unit for a single ship. Behind this unit will be such dressings and appliances as may be necessary for a first dressing and preparation for immediate transport. Each one of the four sanitary ships during a lull, or after an action, will care for the wounded of four battleships, which comprises a division in the battle fleet. The humanitarian units will go to their respective ships, taking along with them their necessary paraphernalia; will take charge of the wounded, look to their immediate removal, and will follow them along to the base. The flow of wounded to the sanitary ships will be continuous and uninterrupted, and the desirable details heretofore outlined can be carried out.

"The medical officers attached to the fighting ships who have participated in the hazards of battle would probably not be physically fit to attend the scores of wounded that would surround them, nor is their equipment sufficient for the needs of such an occasion. With the proposed plan in operation, these medical officers on the fighting ships would be relieved of this great responsibility and the wounded would be better cared for, which would lead to a lessening of suffering and better end-results.

"Upon the completeness with which the organization and equipment of this great plant is prepared and its personnel drilled will depend its success . . . in time of war." And, moreover, it is realized that conditions may arise which will necessitate a modification of the plan in part or in whole, and force the medical department back upon its other resources to meet the peculiar exigencies of after-battle situations in the navy.

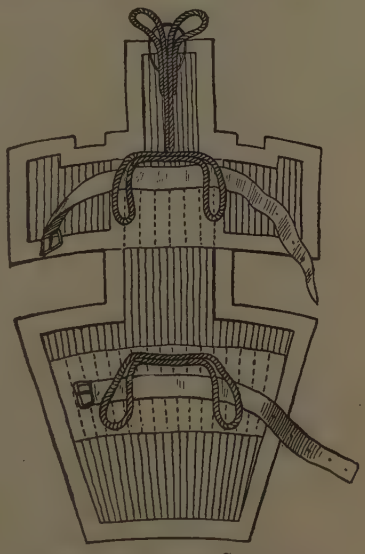

Fig. 374.—Bamboo Stretcher.

With further reference to types of litters designed especially for the transportation of the wounded in naval warfare (discussed under "Methods of Transportation," Vol. V., p. 1062), attention is invited to "the bamboo stretcher," which May[15] exhibited at the 20th Annual Meeting of the Association of Military Surgeons. It is contrived in curious shape—with stretcher section proper about 12 inches wide extending from head to foot and wings to fold over the chest (under arms) and over the legs—of small ($\frac{1}{2}$-inch) bamboo poles, held together on a canvas form by broad canvas facings and supported elsewhere by tacking either over the bare bamboo or through strips of canvas. As used, the canvas form constitutes the lining, and each pair of wings is secured about the body by a canvas strap with buckle. Across the back on the outside, opposite the shoulder and mid-thigh positions, two rope loops for use as handles are attached. Along the back on the outside from bottom to top, where it ends in a loop for vertical transport by block and tackle, a rope is attached in such wise as to insure the greatest measure of security and support. To the inside where the occiput rests a band for supporting the head by folding over the forehead is attached.

This stretcher is comparable with the "apron" stretcher described in Vol. IV., with respect both to use and idea, and has been compared with it by May, point by point, to the undeniable advantage of the bamboo stretcher, particularly as regards flexibility (an important feature under some circumstances aboard ship) and durability. One of the

disadvantages of both these stretchers, though not so prominent in the bamboo as the apron stretcher, is the danger of interfering with the respiration, which, in cases of shock so common in the wounds of naval warfare, would be a matter of serious consideration. This fault cannot be found with the Stokes "splint stretcher," which it is believed still holds its position of supremacy among devices of this class. One of its very important advantages, not specifically mentioned in Vol. IV., but deserving of such, is the sanitary opening to be seen about the middle of the device in the illustration on page 1067 of that volume.

Hospital Ships.—In an admirable and comprehensive article recently published, Pleadwell[18] discusses the rules that will govern the conduct of hospital ships in the exercise of their functions as enjoined upon a signatory state by the provisions contained in the 10th Convention of the Second Hague Conference of 1907. This article represents a full exposition of the main features of the convention above mentioned, studied in connection with and adjusted to the situations imposed by the term of the various problems of naval warfare, especially belligerent activities far distant from base. The reader is referred to this article, which should be read in full.

Dr. zur Verth[35] has also recently contributed a valuable article on this subject (published translation in The Military Surgeon, Vol. XXX., No. 4), to which the reader is referred. He presents a number of old arguments in a new and telling light and also exposes a number of new reasons—economic, professional, and military—for making this provision. He emphasizes the need of hospital ships built for the purpose (not converted), in service not only for peace duty, but in order that complete hospital provision may be ready to hand for any initial belligerent activity. He then discusses the considerations and problems entering into the design of such ships as regards the appropriate arrangement of space, the required capacity and number of such ships as against the estimated list of casualities and in face of the varying circumstances of service, and the medical or sanitary and civil personnel.

The above outlined scheme, which involves the operation of a number of " sanitary ships" proportionate to the size of the fleet, does not in the least obviate the necessity of hospital ships. As already stated, the sanitary ships and the other elements of the scheme which involves them are war provisions which contemplate the transporting of the wounded under the most favorable conditions from the battleships out of the field of belligerent activity to a sanitary base. Moreover, the sanitary ships would remain in the vicinity of the fleet or within such signal distance as would enable quick response to a summons only until their errand had been fulfilled after an engagement, and would then proceed with their burden of wounded to the designated port, leaving the fleet unattended by hospital facilities unless a hospital ship were present as an integral part of the auxiliary component of the fleet.

In other words, hospital ships have lost none of their importance by the formulation of the described newer scheme for after-battle relief. This scheme only affects the number of hospital ships which would

otherwise be required in time of war. It accomplishes the same end more expeditiously, more efficiently, and more economically. Each fleet must still include in its organization a hospital ship to remain with it or in its vicinity at all times in its evolutions during the long periods of peace and in the event of war, and for most, if not all, of the same reasons which were set down at length in the original chapter.

FIG. 375.—AN APPARATUS FOR HOISTING PATIENTS ABOARD THE U. S. HOSPITAL SHIP "SOLACE." (Blackwell in U. S. Naval Medical Bulletin, Vol. V., No. 4.)
Patient in stretcher hoisted all the way and secured.

At the time the original chapter was written the "Relief" was the hospital ship of the United States Navy. Since then this ship has become unseaworthy, and, although she is still used as a floating hospital at one of our stations in the Orient, her place has been taken in the fleet by the "Solace," which is "the only available hospital ship in the United

States Navy and one of the few in the world."* She, like the "Relief," is a converted merchant ship, the remodeling plans of which are an improvement upon those for and based upon experience with the "Relief." Some important features which such a ship should have are lacking, but on the whole she is comfortable at sea and has given a fair degree of satisfaction, as much, indeed, as could be expected from a vessel originally intended for other uses. She is thoroughly equipped for the work of a general hospital, as may be seen by the following extract from a recent descriptive article on the "Solace":[11]

"In the hospital department the capacity for patients is stated as 9 officers, each having a separate stateroom, and 234 enlisted men, for whom there are in place 166 fixed berths, the others being provided for in hammocks and cots. There are three wards on the hurricane deck, with 12, 10, and 8 berths, used as isolation wards for tuberculosis and for the diseases of childhood, which are nearly always brought along by the drafts of young recruits of our enlisted force. The hospital facilities include a laboratory with microscope, ultramicroscope, incubator, laboratory animals, etc., a special dark room equipped for nose, throat, and ear work, and for ophthalmoscopic examinations, a light ophthalmologic room with 20-foot space for vision testing, dispensary, general operating-room with two glass-topped tables and fully equipped *x*-ray and electrotherapeutic room, well-equipped dental office, three strong rooms for insane and alcoholic patients, two dressing-rooms, electrically equipped diet kitchen, steam laundry, steam and formalin disinfecting chamber, and refrigerating morgue.

"The disinfecting chamber is large and serves for linen and the effects of patients on board, and also for material sent from other ships or shore camps. In the morgue the remains of any men who may die in the fleet are received, embalmed, and placed in a metal-lined casket, and on request shipped at government expense to the next of kin.

"A dense air ice-machine furnishes the ice required, even in tropical waters, and supplies cold air to storage-rooms with capacity of fresh provision for about six weeks. 'Distillers' produce about 8000 gallons of fresh water daily. On the broad hurricane deck are wicker reclining chairs for convalescents, tuberculous patients, and others feeling the need of a little rest and relaxation. On this deck tents are often pitched for special cases requiring isolation, and in pleasant weather cots may be placed there.

"An elevator facilitates the transfer of patients from the operating-room and upper deck to the principal wards on the main deck, or to the *x*-ray room and convalescents' ward on the berth deck, two decks below.

"Specially devised cranes permit of patients being hoisted in a Stokes splint stretcher from a boat alongside without discomfort and in a recumbent posture, even in a seaway.†

* Two hospital ships have been laid down in England recently, it is understood, for the Royal Navy.

† "The principle of the hoisting apparatus is as follows: An arm extends out over the ship's side for 8 feet, with a trolley with block and tackle attached, which trolley travels back and forth on the arm. The arm consists of a 6-inch I beam secured to three cross-beams by grips, which permit it to be run out and in as necessary. On the outer end of this beam is a pulley over which is run a guy line attached to the trolley, by means of which the trolley is run out to the end of the beam and secured. The beam can be run out 4 feet or 8 feet and secured to the cross-beams by pins. The trolley has four traveling wheels, two in either side, which run along the lower flanges of the I beam, and two sheaves below the beam, over which the tackle runs to the block. Below these sheaves is a cross-bolt which engages and secures two hooks on the block when it is hauled up. There is a hook on the lower end of the block to which the stretcher is secured by an eight-tailed bridle, which has large hooks on the ends which easily snap on and off the stretcher.

"The most delicate and difficult mechanism about the apparatus is the device for automatically hooking on and securing the block to the trolley when the block is hauled up, thereby making the stretcher with the patient perfectly secure while the trolley is being run in. There are two inverted hooks, one on each side of the

"Nine ordinary boats and two steam launches are provided, and one of the launches is specially devised for convenient use as an ambulance boat. Broad gangways and large cargo ports, placed low in the ship's side, permit the easy reception or transfer of patients in calm water or when alongside a wharf.

"The Red Cross flag flying at the mainmast and the peculiar painting of the ship's side—white with a green stroke 1½ meters in width and running from bow to stern—attract attention, and frequently require the explanation that they are provided as the distinguishing marks of a government-owned hospital ship, by the terms of the Hague Convention of 1907, which extended the provisions of the Geneva Convention to maritime warfare. In the case of a hospital ship fitted out by an individual or society the green band is replaced by one of red."

VII. **Landing Forces.**—The frequent call for expeditionary service from a single ship, division, or fleet, with the object "of effecting a surprise, seizing a position, or punishing uncivilized tribes," places the navy under the necessity of formulating a plan and maintaining and drilling a definite organization for land operations, either in an independent capacity or in co-operation with the army, so that when the moment for action arrives nothing will be left to chance. As occasion for such expeditionary service has developed and will in the future arise more often than otherwise at times of local disturbances, when the navy as a whole may be said to be on a peace footing, *i. e.*, when the ships themselves are not required to engage in hostile activities with an opposing sea force, it is clear that the organization and equipment of the medical contingent of the landing party must be based upon the usual available personnel and outfit. At the same time the organization must be susceptible of rapid expansion in time of war, when, presumably, the complement of medical officers and of the hospital corps would be doubled, or at least greatly increased, and when circumstances might demand and the exigencies of the service permit co-operation with the army. In this connection it must be borne in mind also that the marine corps is a branch of the navy for whose physical welfare the medical department of the navy is responsible, and in whose independent movements the medical department of the navy must be fully prepared to take part. In the event of war and the consequent larger movements of land forces, or in case of a demand for combined intervention on foreign shores for the protection of life and property against uncontrolled massacre and other acts of violence by unorganized revolutionary mobs, or against mutinous rebellion by disaffected soldiers, the marine corps, as in the past, would operate in battalion or in regimental detachments. This would involve a complete medical formation and outfit for service which in every detail would conform to that required by the army medical corps in the field, and in which the " lines of assistance " would be paral-

upper part of the block. When the block is hauled up these hooks impinge against a cross-bolt in the lower part of the trolley. They act as inclined places, and as the block is pulled higher they are tilted out until their points are clear of the bolt, when they resume their vertical position. The hoisting line, or purchase, is then eased off, and the hooks catch securely on the cross-bolt and the trolley is run in by hauling on the purchase.

"Four men are required for operating the apparatus; one to handle the guide-line which controls the stretcher and keeps it from swinging or turning; one to handle the loose end of the purchase and also the guy-line which runs the trolley out and secures it; two to hoist the patient by hauling on the purchase."[5]

lel, as tabulated under "Posts for the Wounded." In co-operating with the army it would probably be desirable to translate the four strictly battleship divisions of the scheme of stations—now become shore stations—into terms used by the army. In the rear of the troops and near the firing-line, though under cover of terrain or other form of protection, there would be mobile relief parties (regimental aid); further in the rear and out of the danger zone or under cover, but "as near the front as the terrain and the military situation will permit," relief stations

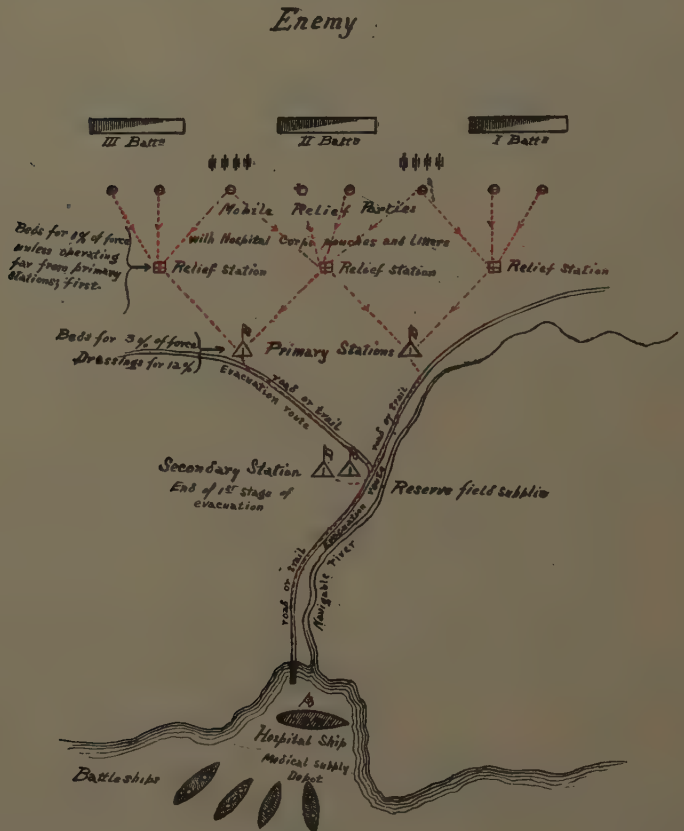

FIG. 376.—ARRANGEMENT OF DRESSING STATIONS AND OF LINES OF COMMUNICATION AND ASSISTANCE FOR LANDING PARTIES IN THE FIELD.

(field dressing stations); still farther back on the route of communication and in efficient relation to the relief stations, but out of the danger zone, primary stations (field hospitals), and at the end of the first stage of transport or evacuation the secondary station (evacuation hospital). This arrangement presupposes operations to be carried on at a considerable distance from the base, and a numerically adequate sanitary corps, which latter would certainly not be the case if the expedition was organized from one ship. "The idea, however, that a fixed succession of

stations should be carried out must be emphatically combated, as it might often happen that a combination of at least two stations would offer a decided advantage."[31] For example, the ship itself would always serve as the base hospital, but it might and often would combine the duties of the secondary station (evacuation hospital). Indeed, it is not possible to formulate precise regulations covering these matters. The proper disposition and location of the medical forces depend inevitably upon the tactical movements and operations of fighting troops as employed in a "rencounter, planned attack, or defense." "It is inadvisable even to attempt at the beginning to indicate locations of dressing stations or field hospitals as long as it cannot be foreseen whether the position can be maintained and where the severe action will develop."[31] The surgeon cannot afford to act too hastily, and must exercise discretion in establishing his dressing stations, for, although "the work of rescue should theoretically begin within the danger zone and during the course of the engagement, the type of engagement, character of terrain, and transportation facilities for the wounded all influence the disposition of the units and the extent of the arrangement of aid and dressing stations." Under any circumstances it may prove necessary, as on board ship, to delay relief measures until after battle, although this would not apply in battles of more than one day's duration. It is certain that the ambulance service would be difficult and inadequate because of the lack of wheeled litters and the dearth of carriers. There should be according to army organization no less than 5 men in the medical contingent for every 100 men of the force landed, but this is impossible in the navy, and 2 per cent. is modestly stipulated as the desired proportion in expeditionary forces. "The situation must be dealt with as best it may. Carts may be seized by the belligerents, navigable streams utilized, and extra details for stretcher service obtained. But whatever devices be exploited, the means for transporting the wounded to the rear and then back to the ship during retreat will remain a source of serious concern to the medical department."[29]

The United States naval medical and surgical outfits for expeditionary enterprises are well adapted for field service, some of the equipment, "as the first-aid packet and the hospital corps pouches, being even more suitable for use on shore than on ships." Steps are being taken by the Bureau of Medicine and Surgery of the Navy Department to perfect the expeditionary outfit, particularly in the direction of reducing weight and obtaining compactness, though at the same time adding to the supplies, especially dressings.

Of course, the different character of the weapons employed in land operations alters the type of wound encountered, the small-bore, jacketed bullets, which at the usual range of fire tend to perforate cleanly, causing in the neighborhood of 90 per cent. of the casualties. Many of the victims of this type of wound are not actually disabled, and hence the greater need of prompt and active first aid. There is not the proneness to suppurate that is commonly seen in shell wounds, and in most cases the first-aid packet will serve as a permanent dressing.

As at sea, so on land, " the basis of the organization of the medical department for war is the military necessity of maintaining the highest possible effective strength of . . . (the fighting force), and of relieving it of its encumbrance of sick and wounded. The first purpose is accomplished, as far as battle service is concerned, by the early treatment of the wounded, especially those who may be expected to recover and resume duty within a short period of time, and by sustaining the *morale* of troops by assuring proper care of the unfortunate wounded; the second, by rapidly evacuating all non-effectives from the zone of operations, thereby enhancing the mobility of the land force."

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CHAPTER CXLI.

TROPICAL SURGERY.*

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The general subject of surgery in the tropics calls for no further discussion (see Chap. LXVIII., Vol. IV., p. 1075), but in the last four years some important discoveries have been made in the etiology and pathology, and, to a less extent, in the treatment of some of the diseases included in this work under the head of "Surgical Diseases of the Tropics." So rapid has been the progress in the study of disease causation and transmission that it is impossible for a busy physician to keep up with the work of the many naturalists, bacteriologists, protozoölogists, and physicians who, all over the world, are daily adding to our understanding of heretofore mysterious maladies. An attempt to set forth very briefly the advances made in the knowledge of those diseases of special interest to surgeons will here be made, with just a hint as to the wonderful promise for the future offered by what has already been accomplished.

Leprosy.—It has been usually admitted since the discovery of the bacillus of leprosy that a full knowledge of the disease and a reasonable hope for a satisfactory method of treatment would depend upon success in obtaining this most obdurate germ in pure culture and by laboratory study "in vivo" and "in vitro." Clegg,[1] by using a medium in which amebæ and bacteria were made to grow in symbiosis, succeeded in obtaining pure cultures of acid-fast organisms from leprous spleens and young nodules from the skin. The bacilli grow well immediately around the living amebæ, and the cultures are then freed from amebæ and the symbiotic organisms by heating. After a few days pure cultures of the Bacillus lepræ appear, which then thrive well alone. The work of Clegg and the identity of the acid-fast bacillus which he obtained in pure culture with the Bacillus lepræ have been fully confirmed by Brinckerhoff and others in Hawaii. Sugai[7] demonstrated that inoculation of Bacillus lepræ in Japanese dancing mice was followed not only by growth at the site of inoculation, but by generalized leprosy throughout the animal's body. Duval[3] succeeded in growing the bacilli with amebæ alone, then in an artificial medium containing some of the products of cell metabolism (tryptophan, cystein, leucin, etc.), and, finally, after the organism had become habituated to artificial media, growths were obtained upon ordinary laboratory media such as blood-agar and serum-agar. It is,

* Supplementary to Chapter LXVIII., Vol. IV., p. 1075.

therefore, still very difficult to start a growth of the Bacillus lepræ from the diseased tissues, but once accustomed to its new environment, cultures of the organism are obtained and carried on indefinitely without trouble, each transplantation taking only a few days to mature. Duval and Gurd[4, 5] produced generalized lesions in dancing mice and also in monkeys from the pure culture. Cultivation of the organism from the nasal mucus is harder to effect, but in 2 cases was successful. The persistence of viable germs outside of the leper's body is shown by the fact that the bacilli can be cultivated from bits of infected tissue kept at room-temperature in salt solution for over eight months.

On the whole, the recent experiments strengthen the hypothesis that leprosy is frequently transmitted by nasal discharges which, it may be, remain infective for months and contaminate rooms inhabited by lepers and articles handled by them. The point of inoculation is probably in the nasopharynx in most cases. There is evidence that inoculation through the skin may occur without a manifest lesion at the site of entrance. The importance of segregation of patients in a community is to be emphasized, but the reasons for the rare and apparently difficult transmission of leprosy from man to man, in spite of the fact that lepers discharge myriads of germs, and that some at least are viable for months outside of the body, have not as yet been discovered. The possibility of insect transmission receives some support from the observations of Long[6] in South Africa, who has found quite constantly that bedbugs, allowed to bite lepers, carry the Bacillus lepræ in the alimentary tract.

As of the innumerable bacilli found in leprous tissue only a small number are demonstrably alive, it is well to notice an observation of Unna,[8] who describes a method of double staining, by which the old bacilli are stained yellow, and the young organisms, presumably living, are stained blue.

In the treatment of the disease no real advance has been recently made. The successful isolation of the germ in pure culture offers a hope that an effective remedy may be prepared from the bacilli. Those who have done most in developing the laboratory study of the germ are working steadily toward the production of immunity and the preparation of material for diagnostic and curative purposes, but as yet no authoritative statement has been made of the practical value of the many preparations attempted.

Deyke,[2] of Constantinople, isolated from leprous nodules and continued in pure culture a streptothrix which he named Streptothrix leproides. He claims no demonstrable relationship between this organism and the Bacillus lepræ, but states that the streptothrix contains a substance which exerts a powerful influence on whatever excites the disease. He obtained from the streptothrix a peculiar neutral fatty material, which he named nastin. Used experimentally on lepers, nastin was found to produce very decided and sometimes violent reactions, constitutional as well as local, but a solution of nastin in benzoyl chlorid (nastin B) injected in the tissues provokes no unpleasant symptoms, and

within limitations has apparently exerted beneficial effects on some cases of leprosy. Well-marked lepromata are resistant to the remedy, but other skin lesions, ulcers, and even extensive infiltration have been observed to heal or disappear. As usual, on the appearance of a new remedy, favorable reports on the use of nastin were at first very numerous. Later reports in many cases failed to confirm the value of the remedy, which, however, is still used in the East. The use of the *x*-rays in leprosy has proved, on the whole, a failure, although there is no doubt that some nodules disappear under the treatment. The ancient remedy, chaulmoogra oil, in connection with hot baths, strychnin, tonics, and generous diet, still remains the least disappointing treatment in leprosy.

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Oriental Sore.—Further research into the nature of Oriental sore, the best-known and most widely spread of the so-called endemic ulcers, has done much to clear up the subject. Three types of the disease are now recognized: Non-ulcerating sore, a superficial ulcer, and the deep-seated Oriental boil. The organism found in the lesions have been differentiated as a species from those of the same genus causing kala-azar. They are placed in the genus Leishmania of the family of Herpetomonidæ. Leishmania tropica, the species found in Oriental sore, will, in all probability, be found to include several varieties which may also be pathogenically different, and thus account for the decided differences in the skin lesions.

Wenyon, who studied Oriental sore in Bagdad where it is omnipresent and known as the "date boil," states[4] that nearly all the children of the city have the disease between the ages of one and three years, and are afterward considered immune for life. There is usually a single sore, but two, three, or even four are not very uncommon. The duration is about one year, and the lesion upon healing leaves a very characteristic scar which is to be observed upon the majority of the inhabitants. The lesions usually make their appearance in the autumn, suggesting summer insects as the means of transmission. The sores are practically always on exposed surfaces—the legs, arms, and face—and the insect carriers are probably not lice nor fleas, but flies or free-living bugs. The carriage of Leishmania by insects has received more direct proof by the work of Patton, who found that the parasites of kala-azar become flagellated in the alimentary canal of bedbugs, and of Carter,[1] who studied the organisms in 7 cases of non-ulcerating Oriental sore, and found a very similar parasite in the alimentary

canal of Erthesina fullo, a pentatomid bug, widely distributed in India, which often enters houses and is a blood sucker.

The virus of Oriental sore can be directly inoculated from man to man, and the lesions have been produced experimentally in dogs and monkeys. Mechanical transmission of the virus from unprotected sores by common flies must be considered as not improbable.

Allied genera of the same family as Leishmania are Herpetomonas and Crithidia, flagellated organisms parasitic in insects. The entire family is also closely related to the Trypanosomidæ, the members of which are parasitic in vertebrates and invertebrates, and some of which cause fatal disease in man and domestic animals, being quite certainly carried by blood-sucking insects.

In view of the great importance of the flagellates in human and veterinary medicine, much attention is being given to them by protozoölogists, and it would be very desirable that more study should be directed toward the possibility of those that are common intestinal parasites of insects, becoming by development capable of existence in the body-cells of man and the higher animals and causing disease.

Oriental sore has been reported in a few instances from Brazil and French Guiana, and quite recently Darling[3] has reported a case at Panama containing a flagellate closely resembling Crithidia. The lesion followed upon the bite of a tabanid fly and was apparently a typic Oriental sore. The sore had lasted four months when it was subjected to treatment. It was excised well beyond its margin and healing resulted in about forty days.

The treatment of Oriental sore is seldom so radical, according to those who have had most experience with the disease. An expectant plan with simple dressings is usually adopted. Benoit Gonin[2] reports very rapid results in a series of cases treated with permanganate of potassium. He softened and removed the crusts, washed the sore well with antiseptic solution, and then filled it with dry permanganate, applying an occlusive dressing with collodion. Healing under this treatment occurred in from six to twenty-one days, and no ugly discolored scars resulted.

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Yaws.—The organism Treponema pertenue, found by Castellani in 1905, is now generally accepted as the specific cause of yaws or frambesia tropica. Its presence is constant in the primary lesions and in the unbroken papules of the general eruption. It may also be found in the spleen, the lymphatic glands, and in the bone-marrow. The blood is infectious, as it may reproduce the lesion when inoculated, but as yet the organism has not been microscopically shown in the blood. Inoculation of yaws from one human subject to another has been repeatedly demonstrated in the last fifty years, and more recently monkeys and

rabbits have been inoculated and the infection carried on through a series of animals. Nichols[2] found that rabbits can be inoculated in

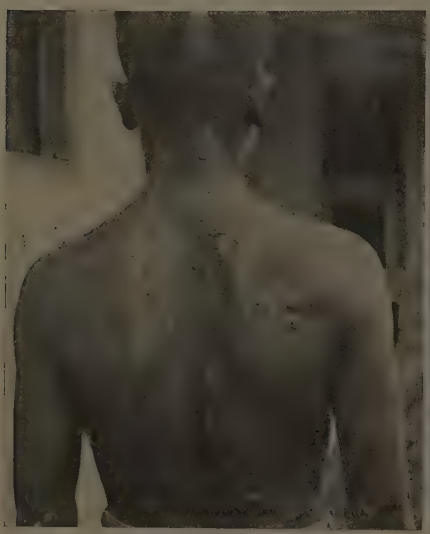

FIG. 377.—FILIPINO SCOUT: GENERAL ERUPTION OF YAWS ON BACK.

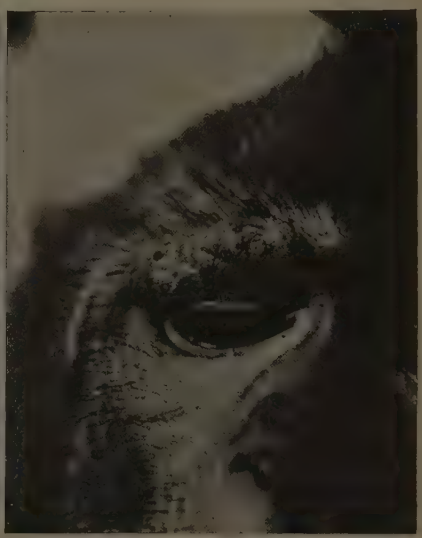

FIG. 378.—YAWS ON MONKEY'S EYEBROW. (Army Medical School.)

Inoculated with infected tissue of rabbit's testicle; incubation period, fifteen days; duration, thirty-eight days.

FIG. 379.—YAWS NODULE IN RABBIT'S TESTICLE. (Army Medical School.)

Incubation period, thirty-two days; duration, ten days.

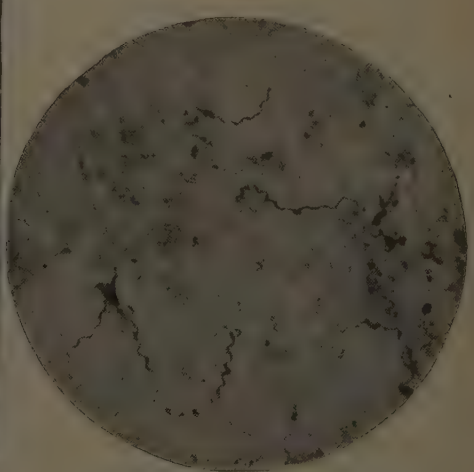

FIG. 380.—TREPONEMA PERTENUE FROM INFECTED RABBIT'S TESTICLE. ×1500 GIEMSA STAIN. (Army Medical School.)

the testicle with both yaws and syphilis, the lesions of the two diseases being markedly different. In yaws the infection shows itself by enlargement of the testicle and the presence of a nodule. Under

the microscope, necrosis of the tubules of the testicle, an infiltration with round cells and a new edematous connective tissue, are seen.

In spite of the very close resemblance in many ways of syphilis and yaws, the diseases are to be considered as quite distinct. The morphologic differences between Treponema pertenue and T. pallidum are very slight, and complement fixation occurs when a syphilitic antigen and the serum of a yaws patient are used, but the diseases are not mutually protective one from another. There is no reason to consider yaws as ever hereditary. Indeed, parents are quite often infected from their children. The disease is very common in childhood, and nursing mothers frequently develop the initial lesion on the mammæ from suckling infected children. Castellani[1] states that in Ceylon the primary lesion sometimes makes its appearance on the trunk just above the pelvis in native women who have the habit of carrying their children astride of the hip. Probably a slight abrasion or wound of the skin is the point of entrance, and there is no doubt that in the vast majority of cases direct contact is responsible for the spread of the disease.

As to treatment, it is probable that in salvarsan we have by far the best remedy. Strong[3] reports from Manila rapid and complete recovery under its use.

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Tropical Dysentery.—In the etiology of amebic dysentery at at least one new species, Entameba tetragena, has been proved to be pathogenic, and one or two others are probably so. The vexed question, whether all intestinal amebæ are not potentially pathogenic and whether many of the numerous species existing in stagnant water may not become habituated to a parasitic existence and cause dysentery, is as yet unsettled. A well-marked case of amebic dysentery,[1] reported from Alaska, in a patient who had been for years in the country and never in the south, is suggestive. During the recession of the spring floods of the Yukon River the banks became swampy with pools of standing water, from which this patient had often drunk. Amebic dysentery, rare even in temperate climates, is practically unknown in the Arctic regions, and in this case contamination of the water by dysenteric discharges seems to be excluded.

The surgical treatment of chronic dysentery by local applications or irrigations, with or without an artificial opening into the bowel, has practically supplanted the use of drugs given by the mouth. Ipecacuanha is undoubtedly the most useful drug in amebic dysentery, and in the exacerbations which occur in the course of the chronic form it promptly removes the organisms from the stools and relieves the painful symptoms. In India it is considered the remedy " par excellence " for the torpid, painful liver accompanying dysentery and as a preventive of liver abscess. The drug, used in the form of powder,

must be given in large doses to be effective, and, as vomiting should by all means be prevented, it is best to administer it in boluses coated

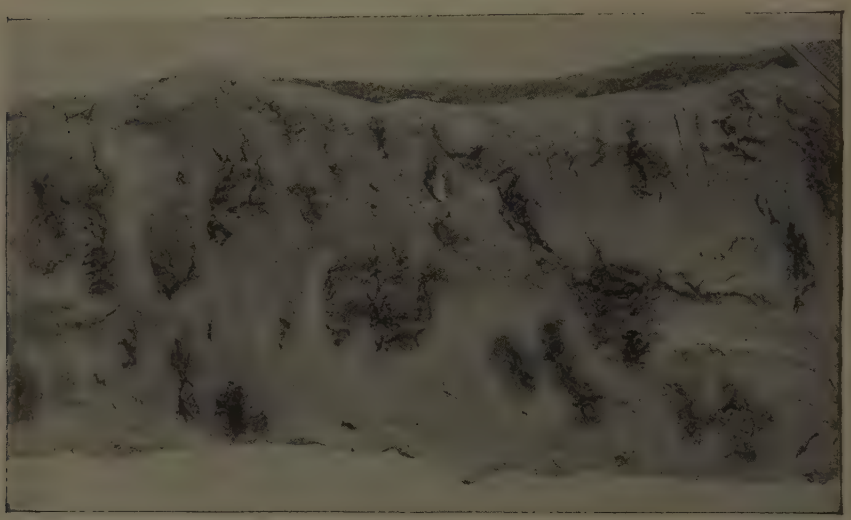

FIG. 381.—COLON. MULTIPLE ULCERATIONS IN SEVERE CHRONIC AMEBIASIS. (McDill.)

with salol, which is not acted upon in the stomach, so that the remedy may reach the bowel without causing nausea. Ipecacuanha may also

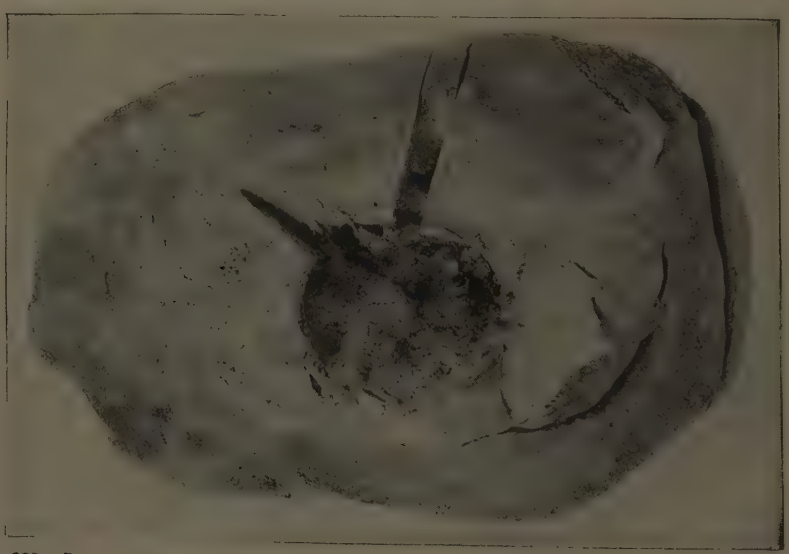

FIG. 382.—LIVER. SOLITARY SUPERFICIAL AMEBIC ABSCESS, OUTER SURFACE, RIGHT LOBE. (McDill.)

be given by high enema, and in one case on the Isthmus of Panama, reported by Brem and Zeiler, a cure was obtained by administering the drug in doses of 45 grains in starch emulsion directly to the colon after

an appendicostomy. For high irrigation by the rectum or after appendicostomy, quinin solution in warm sterile salt solution is to be preferred. Storck[5] recommends hot irrigations of a solution of copper sulphate (1: 10,000) as hot as can be borne.

The operation of appendicostomy, used also for many other conditions, such as chronic constipation with auto-intoxication, mucous colitis, and even for the purpose of introducing nourishment in cases of inoperable gastric cancer, is, in properly selected cases of amebic dysentery, the only satisfactory method of directly reaching the diseased parts. Not the least advantageous feature of treatment through an artificial opening is the great relief it gives to distressing neurasthenic symptoms. In a few cases of acute dysentery with threatening symptoms the operation has been used to save life. In chronic dysentery apparent cures are often obtained and, at least, there is always very great improvement in the condition of the patient.

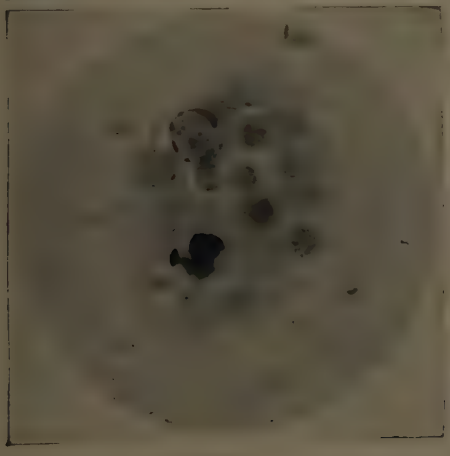

Fig. 383.

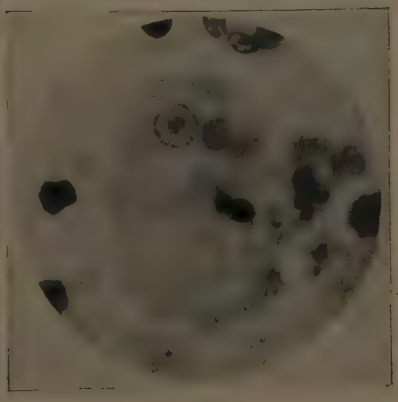

Fig. 384.

Figs. 383, 384.—Pathogenic and Parasitic Entamebas Found in Dysenteric Stools. (McDill.)
Fig. 383.—Entameba histolytica (Schaudinn). Fig. 384.—Entameba histolytica, variety tetragena.

Pettyjohn[4] uses a modification of the usual operation, which presents several advantages. An incision is made 3 inches long, directed downward, parallel to the fibers of the rectus muscle and $\frac{3}{4}$ inch internal to its outer border, beginning $\frac{1}{2}$ inch below the level of the umbilicus. The rectus is well exposed and retracted and the abdomen opened through the posterior tissues. The exact location of the appendix is then determined by exploration with the fingers, and over this point a vertical stab-wound is made with a straight bistoury, having first protected the intestines with a thick gauze pad held to the inner wall of the abdomen. The appendix is drawn through the stab-wound with a narrow pair of forceps until the intestine is in contact with the abdominal wall, and is secured by a few sutures at the opening in the skin. The large wound is then closed and the appendix is cut off at a point 1 inch beyond the skin, and a catheter introduced at once. In

this operation the appendix is brought out over its exact site and the intestine is in direct contact with the belly wall, securing a straight passage without danger of stretching the appendix. The exploratory wound is aseptic and can be completely and permanently closed, while there is not the danger of hernia, which must be considered where the appendix is sutured in a large abdominal wound. The irrigations can be begun at once.

Amebic Abscess.—Abscess of amebic origin, other than that of the liver, has been heretofore looked upon as very rare. In the lung, with or without direct communication with abscess of the liver, it is, indeed, not very uncommon. In a few cases the lesion has been found in the spleen or in the perirenal region. Cerebral abscess, however, must now be considered as not a very infrequent occurrence in amebiasis, and one that has evidently been often overlooked. Kartulis[3] states that in Egypt out of 184 hepatic abscesses treated in hospital, 7 were complicated with cerebral abscess, and from 200 cases outside, 4 brain abscesses were observed, or about 3 per cent. of all cases.

Amebic abscess of the brain is invariably a complication or a sequel of a like lesion of the liver, and is formed in much the same way, being irregular in contour and without recognizable abscess wall. Living amebæ are found in the pus, and especially in the partially necrosed tissues surrounding the abscess. Meningitis is usually absent. The symptoms are those of cerebral abscess in general, with, perhaps, greater intracranial tension than usual and consequently more severe headache. Jacob[2] reports 2 cases treated surgically. In both, the patients had chronic dysentery followed by hepatic abscess, successfully evacuated by the transpleural route. The patients were apparently convalescent and, indeed, almost well when the cerebral symptoms were ushered in by headache of extreme severity. As soon as the brain abscesses could be correctly localized they were evacuated, but death resulted in both cases.

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4. Pettyjohn: Jour. Amer. Med. Assoc., liv., 869.
5. Storck: New Orleans Med. and Surg. Jour., lxiv., 39.

Elephantiasis.—The causation of elephantiasis is still a matter of dispute, and many cases of the disease are reported certainly not of tropical origin, with no history of filarial infection and where the organisms cannot be demonstrated in the blood. The presence of a special germ causing the recurrent attacks of local inflammation and fever which so closely resemble erysipelas has been claimed by Le Dantec,[4, 5] who found a diplococcus obtained by blistering the affected parts and also in the blood during acute exacerbations. He, therefore, considers elephantiasis to be a chronic dermatitis due to this "dermococcus,"

and an occasional secondary infection with streptococcus producing the erysipeloid attacks. Obstruction to lymph circulation undoubtedly plays a part in the production of the condition, but this obstruction is not necessarily filarial, although probably so in the endemic elephantiasis of the tropics. Elephantiasis of the scrotum is only cured completely by removal of all the diseased tissue, for if any is left the blubbery material begins again to be formed at the site of operation. Elephantiasis of the leg is usually considered incurable, although much may be done to reduce the deformity and enable the patient to get about. Sir R. Havelock Charles, formerly of Calcutta, now of London, in a letter to the editor describes a radical operation done by him in 1903 where the limb was completely decorticated, all diseased tissue dissected off from the toes to the knee, leaving only the skin of the heel and the sole of the foot. The enormous raw surface left was grafted with large patches of skin and a recovery took place without recurrence. Before operation the limb was treated by rest and elevation, local steaming with massage, and the use of a rubber bandage. Charles warns against the use of the knife unless the operation is to be a radical one, such procedures as cutting away wedge-shaped segments or partially removing the diseased tissue being unsurgical and of no permanent benefit. Judging from the literature of the last few years, the radical operation has found few or no imitators. Castellani's method[1] of treating elephantiasis of the lower extremity has given very good results in selected cases. It consists in complete rest in bed, bandaging with a flannel or rubber bandage, and the daily injection of "fibrolysin," which is a mixture of thiosinamin and salicylic acid. The dose is from 2 to 4 c.c. in water, given by deep injection into the affected parts or in the gluteal region. The bandaging must be done carefully and pads placed underneath to increase the pressure on the hardest parts, and for this purpose gauze bags filled with small shot are used. The pressure on the whole limb must be well distributed, as the parts with insufficient pressure will become swollen. Most patients cannot stand the rubber bandage, which is found especially useful in cases where the skin is hard and verrucose. After three to six months of this treatment the size of the limb is much reduced and the skin is elastic and can be pinched into folds. Long strips of the skin may then be removed and the wounds stitched. The above treatment has given only slight and temporary benefit in recent cases with frequent attacks of fever, but in old-standing cases, where fever is absent and the limb is hard and verrucose, the effect is much better and more lasting. The patients should wear elastic stockings and occasionally use the rubber bandage after treatment to prevent recurrence.

Handley[3] treats elephantiasis of the leg by his operation of "lymphangioplasty," in which he introduces long silk threads throughout the whole length of the diseased skin until sound tissue with normal lymph circulation is reached. By capillary attraction the threads conduct the lymph from the region where it is obstructed to where it may be removed by absorption. In the first case treated by this procedure

there was infection of the thread tracts on the ninth day, considered to be from the special diplococcus of the disease. Afterward a vaccine was prepared from this germ, by which the patient was immunized and the lymphangioplasty was repeated with excellent results. Dubruel[2] reports partial success with an antistreptococcic serum of his own preparation, and also advises the administration of large doses of perchlorid of iron.

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CHAPTER CXLII.

SURGERY OF THE FEMALE GENITO-URINARY ORGANS.[1]

By E. E. Montgomery, M. D., and John M. Fisher, M. D.,

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Surgery of the Vulva and Vagina.

By John M. Fisher, M. D.,

Philadelphia.

The anatomy and functions of the investing tissues of the pelvic organs, as well as the varieties, immediate clinical significance, remote consequences, and treatment of the diseases and injuries of the vulvo-vaginal structures presented in the preceding volume (Vol. V., p. 387), with but few exceptions, represent in essential details the teaching upon these important subjects to-day. Certain advances in our knowledge of the pathology and treatment of obstetric injuries and their mechanic sequelæ, however, merit further consideration.

PUERPERAL INJURIES OF THE PELVIC OUTLET.

The principles underlying the surgery of most of these abnormalities are now generally recognized, and although their practical application has led to the development of a variety of operative measures of variable value, the advantages of the flap-splitting, cleavage, and resection procedures over the denudation methods of Sims and Emmet and their numerous complicated modifications are fully appreciated by gynecologic surgeons everywhere.

Lacerations and Relaxations of the Posterior Vaginal Wall and Pelvic Floor.—The flap-splitting procedures, of which the operation described in Vol. V., p. 440, is a type, fulfil the indications in a large proportion of instances. It has been observed, however, that while the integrity and functions of the vagina and pelvic floor are thus restored in some cases, in others the posterior vaginal wall above the introitus sooner or later again prolapses through the vulvar orifice. This is accounted for by the detached relationship of the vagina to the pelvic floor preceding the operation, a condition that is characterized by prolapse of the vaginal wall without involvement of contiguous structures, and may occur independent even of any lesion of the perineum or pelvic floor. Considering the structure involved, this form of prolapse may well be designated posterior colpocele.

[1] Supplementary to Chapter LXXI., Vol. V., p. 351.

To better appreciate the pathology of the condition, as well as the surgical indications for its correction, a few words concerning its etiology may prove of value.

In the presence of certain abnormal obstetric conditions the presenting part engages the vaginal tube in a fixed position, pushing it forward in the form of a detached fold or of a reduplicated circular cuff. This separation of the vagina from its surroundings becomes still more pronounced as the levator loop retracts over the fetal head. The defective support of the parts subsequently and the resulting subinvolu-

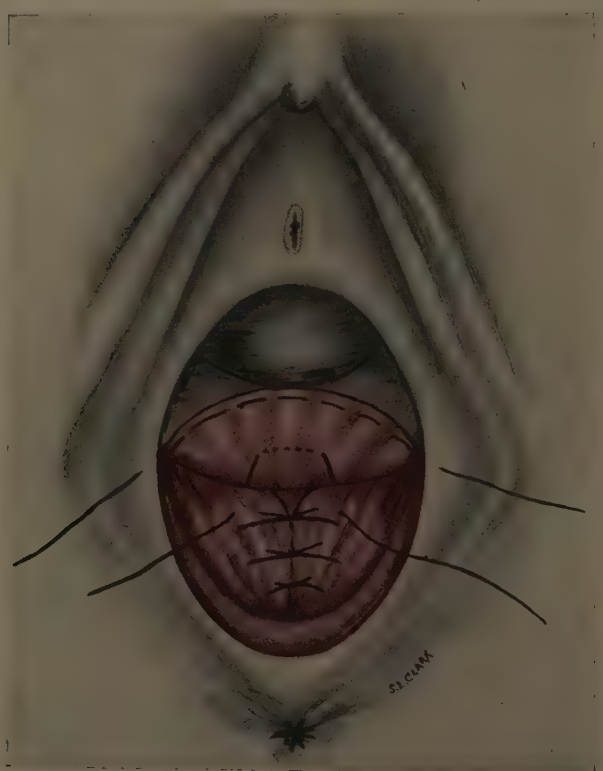

FIG. 385.—LEVATOR MUSCLES SUTURED TOGETHER. BURIED SUTURE ATTACHING VAGINAL FLAP TO EDGE OF LEVATORS. CROWN STITCH ALONG FREE EDGE OF VAGINAL FLAP.

tion, together with the venous stasis and varicose dilatation of the vaginal plexus, soon lead to the formation of redundant and prolapsed vaginal structure, as indicated by the appearance of an anterior or a posterior vaginal protrusion, or both. If the levators remain uninjured and retain their tonicity the detached vaginal walls usually appear to be well supported, and the tendency to prolapse may, at first sight, escape detection. But a bearing-down effort generally discloses the true condition of the tissues, or by introducing the index-finger the vagina above the introitus may be drawn down and everted or rolled out between the

vulvar lips not unlike the reduplicated sides of a bag partially turned inside out. If, in addition, the levators have been ruptured or overstretched, leaving a relaxed and gaping vulvar orifice, temporary support of the detached vaginal wall is not alone wanting, but an aggravation of the condition is sure to follow.

In cases of this type involving the posterior vaginal wall the indications are not only to re-establish, if necessary, proper pelvic support by restoring the anatomic integrity and functions of the levator loop, but to prevent recurrence of the prolapse by attaching the vagina to the

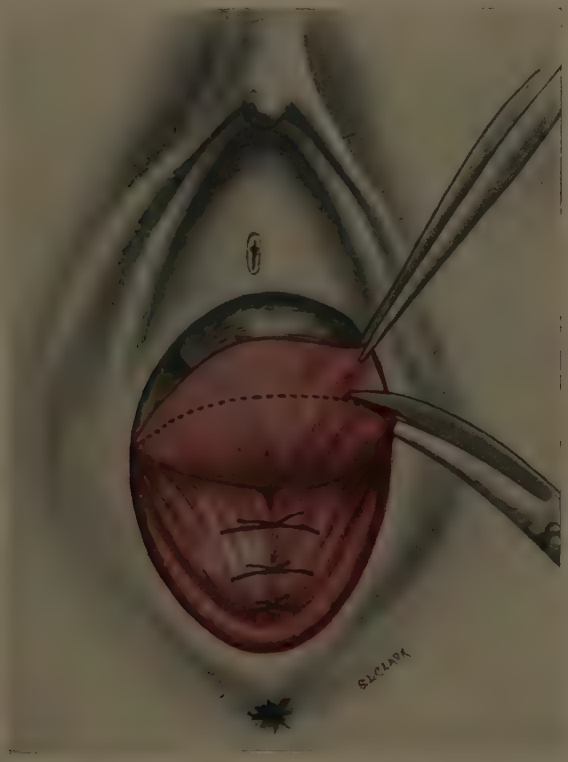

FIG. 386.—TRANSVERSE RESECTION OF REDUNDANT VAGINAL FLAP.

more or less fixed muscular floor with or without previous resection of the redundant tissue, as may be indicated.

Technic.—All associated uterovaginal abnormalities demanding surgical attention are first corrected. The upper and outer caruncles on each side are fixed with shepherd's crook tenacula. A sharp-pointed scissors curved on the flat is now thrust into the tissues below the inner side of one tenaculum, and a **U**-shaped incision is made following the vulvovaginal border to the corresponding point on the opposite side. This incision is deepened with scissors and by blunt dissection until the connective-tissue layer, or plane of cleavage, between the rectum and

vagina permits an easy separation of these structures by gauze pressure or with the fingers to the extent of $1\frac{1}{2}$ inches or more. The dissection is continued downward and outward toward the pelvic wall on both sides of the rectum and vagina until the relaxed levator ani muscles and fascia are exposed, or until the resisting edge of the intact musculature can be felt (Fig. 133, p. 439, Vol. V.).

The vaginal flap thus formed is now seized with a tenaculum or hemostat and held out of the way by an assistant. Pushing the rectum back with the index-finger of one hand, which likewise acts as a guide to the edge of the muscle, the surgeon, with a medium-sized,

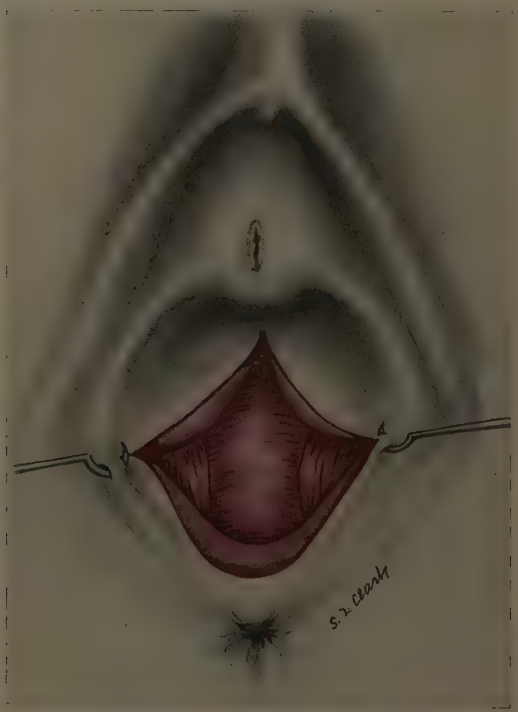

FIG. 387.—RESECTION OF PERINEUM AND ENTIRE THICKNESS OF POSTERIOR VAGINAL WALL. RECTAL WALL PROTRUDING BETWEEN EDGES OF LEVATORS.

strong, round, well-curved needle, armed with No. 1 chromic catgut, picks up and transfixes the levator fibers and fascia from the depth of the wound on one side, passes the needle across the rectum, and secures a corresponding portion of the muscle and fascia on the opposite side. Upon tying this suture both levators are drawn into close apposition, overlying and obliterating the forward bulge of the rectum.

The free ends of this suture left long are now used for traction to facilitate the introduction of an additional suture above and another below it. In order to secure good pelvic support the uppermost suture should be so placed that a sense of moderate tension is experienced on tying it.

Next in order is the disposal of the upturned vaginal flap. In cases of moderate prolapse (those most frequently met with in practice) very satisfactory results may be secured without any sacrifice of structure.

As stated, fixation of the vaginal wall to the underlying muscle and fascia is one of the essentials to success in all operations of this character, and in moderate prolapse this is satisfactorily accomplished by suturing the base of the vaginal flap, submucously, to the edge of each levator where it diverges from its fellow above their line of union (Fig. 385). When tied this suture not only fixes the vagina to the pelvic floor,

FIG. 388.—LEVATOR MUSCLES SUTURED TOGETHER. SUPERFICIAL FREE RAW EDGES WITHIN THE VAGINA PARTLY APPROXIMATED. BURIED SUTURE ATTACHING VAGINAL FLAPS TO LEVATORS.

FIG. 389.—APPROXIMATION OF DEEP PERINEAL STRUCTURES OVER SUTURED LEVATORS.

but closes what otherwise would remain a triangular dead space between the vagina and the levators.

A catgut suture is now introduced at the upper angle of one side of the wound, entering the skin $\frac{1}{8}$ to $\frac{1}{4}$ inch from the raw surface, and running along the whole length of the free edge of the vaginal flap, the needle emerging at a corresponding point on the opposite side. This, when tied, restores and narrows the vaginal entrance. Three or four transverse sutures are usually sufficient to close the remaining portion of the wound and complete the operation.

In the more pronounced cases of prolapse or where there exists a

greater redundancy of vaginal structure, more or less of the distal portion of the vaginal flap may be removed by a transverse resection (Fig. 386). The remaining portion of the flap is then fastened to the levators and the wound closed as described.

The necessity for doing a resection of the tissues, and the way in which it should be done to meet the demands in individual cases, depends upon the degree of prolapse and upon the experience and judgment of the surgeon.

FIG. 390.—VAGINAL SUTURES ALL TIED. SUPERFICIAL PERINEAL SUTURES INTRODUCED FOR RESTORING THE ANATOMIC INTEGRITY OF THE BULBOCAVERNOSUS AND THE TRANSVERSUS PERINEI MUSCLES AND FOR APPROXIMATING SKIN EDGES.

FIG. 391.—OPERATION COMPLETED.

In all cases of excessive redundancy of vaginal structure I prefer to operate as follows:

The remains of the hymen below the orifices of the vulvovaginal glands are fixed by shepherd's crook tenacula and held by an assistant. A tenaculum forceps catches the skin at the lowermost point of the existing perineovaginal border on a line with the anus. This point necessarily varies in accordance with the absence or presence of a deep perineal tear involving the transversus perinei and bulbocavernosus muscles. The crest of the prolapsed vaginal wall is next seized with another tenaculum forceps and held by an assistant. The position of these four fixed points, with the exception of the last one, which is usually situated

at a higher level in the vagina, correspond with those taken to outline the Emmet operation (Vol. V., p. 435, Fig. 131).

The vaginoperineal border is now split with curved scissors, the recto-vaginal structures are separated by cleavage with gauze or fingers, and the levators with their overlying fascia are exposed as already described. The vaginal flap is held out of the way while the surgeon transfixes and unites the levators. A triangular section of the vaginal flap corresponding in size with the outlines indicated by the fixed tenacula is now removed. In accordance with the condition and mobility of the tissues and in order to avoid undue subsequent tension along the line of suture the resection should be done so as to leave either a straight or a more or less convex border of each raw edge within the vagina (Fig. 387).

Fixation of the vaginal wall is secured by fastening the vaginal flaps on either side to the levators with one or two submucous sutures (Fig. 388).

The inferior fascial plane, including (if indicated by the resected perineum) the retracted transversus perinei and the bulbocavernosus muscles, are imbricated and sutured together to reinforce the pelvic floor, restore the musculature of the perineum, and to re-establish the normal approximation of the vulvar lips (Fig. 389).

The superficial structures may be closed by a continuous or interrupted suture of chromic catgut or by a submucous stitch, either as a coincident procedure with the approximation of the deeper structures from above downward or as a final step in the completion of the operation (Figs. 390, 391).

ANTERIOR COLPOCELE; COLPOCYSTOCELE; HERNIA OF THE BLADDER OR TRUE CYSTOCELE.

Surgeons generally still apply the term cystocele to all protrusions of the anterior vaginal wall, irrespective of the structures involved, although, as first pointed out in the preceding volume, prolapse of this portion of the vagina may occur independent of any association with the urinary bladder, forming a distinct entity recognized and described as anterior colpocele, while the designation cystocele was retained for all cases where the vesical base formed a part of the vaginal protrusion. More recent observations prove, however, that prolapse of the vaginal roof involving the bladder may present itself in one of two forms, either as a relaxation of the intact vesicovaginal septum which I recognize as a colpocystocele, or as a hernia of the bladder through a fascial and muscular defect forming a true cystocele. Colpocystocele, unlike anterior colpocele, always is associated with other pelvic abnormalities that have preceded its development, and a true cystocele or hernia of the bladder differs from each of these both pathologically and clinically.

The differentiation of the three conditions, therefore, is essential to a proper appreciation of the surgical indications for their correction.

Anterior colpocele occurs as a result of certain obstetric complications that lead to separation and prolapse of the vaginal wall from the vesical base without disturbing the fascial planes that maintain the

anatomic position and normal relations of the bladder to other pelvic structures.

The abnormality, with but few exceptions, is met with during the first and second decades of the child-bearing period. A coexisting lesion of the pelvic floor may or may not be present, although a lacerated or relaxed state of these structures always aggravates the condition, and in exceptional cases bears a causal relation to its development.

Among the distinguishing features of neighboring structures is the absence of uterine ptosis; in fact, the uterus bears no relation whatever to either the production or maintenance of an existing colpocele. This organ is usually found occupying a comparatively normal and well-poised forward position. A retrodeviation may exist, but the coincident and pronounced downward displacement of the uterus, so common in cases of colpocystocele, is not present.

The prolapsed vaginal wall usually is hypertrophied and rugous, and careful palpation may disclose the mobility of the vaginal protrusion below a fixed vesical floor.

Residual urinary retention and its retinue of possible evils are noted by their absence, although an irritable condition of the bladder and frequency of urination superinduced by the overfilled and varicose vesical plexus are common symptoms.

Treatment.—Resection of the redundant vaginal structure and closure of the wound with continuous or interrupted sutures of chromic catgut (Anterior Colporrhaphy, Vol. V., p. 442).

Colpocystocele, or prolapse of the entire thickness of the vesico-vaginal septum, unlike anterior colpocele, is not a primary condition, but is secondary to and associated with other pelvic abnormalities that are responsible for its development, of which an indefinite degree of uterine prolapse is the most constant as well as the most important factor, not alone as a cause, but in maintaining a continuance of the condition.

A relaxed or lacerated pelvic floor, by its influence on the position of the uterus, predisposes to its development, and in cases where a colpocystocele already exists the abnormality always leads to an aggravation of the condition.

While colpocystocele, like colpocele, is a sequence of certain obstetric or puerperal complications, the former is more gradual and more remote in its development than the latter, and usually is encountered in the last decade of the reproductive period, during and following the atrophic changes incident to the establishment of the menopause, becoming more pronounced and increasingly progressive with advancing years.

The vaginal protrusion constituting colpocystocele, although variable in appearance, rarely is hypertrophied, and usually presents a more even surface than simple colpocele. Combined palpation with a sound in the bladder and a finger in the vagina discloses the sulcus formed by the base and posterior vesical wall corresponding to the situation and size of the vaginal enlargement. An irritable condition of the bladder and frequency of urination, due to the disturbed circulation of the parts and

residual retention, are frequent symptoms. Ammoniacal decomposition of the retained urine and phosphatic formations resulting in cystic inflammation, while not common, are among the most distressing complications.

Treatment.—The treatment of colpocystocele may be classified as prophylactic, palliative, and surgical.

Prophylactic.—Careful obstetrics and the early recognition and correction of puerperal lesions that lead to its ultimate development are the secrets of success in the prevention of colpocystocele, and of the latter the most important to be considered are all those abnormalities that tend to the production of uterine ptosis, which, as already stated, almost invariably is a necessary forerunner of the condition.

Palliative.—The palliative treatment of colpocystocele consists in obliterating the slack and restoring the tension of the vesicovaginal septum by pushing the prolapsed uterus backward and upward in the pelvis to a point above or to as near the normal level as possible, and by maintaining it in this position with some form of vaginal support.

The means available for the accomplishment of this purpose in suitable cases depend upon the age of the patient, the degree of uterine prolapse, and the condition of the pelvic floor. In women with incomplete uterine prolapse, during the first and second decades of the reproductive period and in whom the pelvic floor has escaped extensive injury, sufficient elevation of the uterus to obliterate the colpocystocele may be secured by the use of one of the various forms of self-retaining pessaries recommended for the treatment of backward and downward displacements in general, and of these the Smith-Hodge and the Munde types fulfil the indications best.

Unfortunately, the defect in the pelvic floor in the vast majority of these cases, even in young women, is such that the ordinary forms of retroversion pessaries cannot be retained. If the levator loop has been deeply lacerated or is relaxed, but still presents a shelving process of intact muscular fibers and fascia, above a gaping vaginal orifice, even in the presence of complete uterine and vaginal prolapse, the prolapse in many cases may be corrected and the colpocystocele obliterated by the introduction of what is known as the Menge pessary. This instrument consists of a ring with a fixed cross-bar holding a detachable stem (Fig. 392).

Fig. 392.—Menge's Pessary.

The pessary is introduced with the stem in position. The ring distends the upper portion of the vagina, raises and supports the uterus, and obliterates the colpocystocele, while the stem rests in the vulvo-vaginal orifice and thus keeps the ring from turning over. The removal of the instrument is accomplished by first detaching the stem from the cross-bar, then turning the ring on edge, when it is readily extracted with the finger.

This instrument, however, precludes sexual relations, and is more particularly adapted, therefore, to the treatment of colpocystocele in old women. I know of no conservative measure that has given me more satisfaction in gynecologic practice than the use of this form of pessary in the treatment of procidentia and colpocystocele. There is no exaggeration in stating that the instrument can be utilized in no less than 50 per cent. of these cases. Women who have passed the reproductive age rarely consent to an operation for a radical cure of the condition after having been properly fitted with one of these instruments.

The Menge pessary not only obliterates the vaginal protrusion by supporting the uterus at a higher level, but it likewise relieves the vulvovaginal orifice from further distention by the protruding uterus.

In not a few of those wearing the instrument the musculature of this orifice sooner or later regains some of its lost tone, and in time becomes more narrowed, permitting the use of a much smaller pessary.

If the fascial and muscular support of the lower segment of the vagina has been completely destroyed, no form of self-retaining pessary can be worn, and the only so-called palliative measure of any value is the use of one of the various forms of cup- and stem-pessaries, supported by straps attached to an abdominal belt. Of all devices, this is the most objectionable. The instrument always is a source of discomfort and irritation, and frequently leads to the formation of ulcerative processes from friction and pressure that may terminate in inflammatory complications or degenerative changes of a more serious character.

The contraindications to the use of all forms of pessaries, as well as the care that should be exercised in their employment, are referred to in every systematic work on gynecology and need not be detailed here.

Surgical.—Advanced surgeons everywhere are beginning to realize that in cases of pronounced colpocystocele there is no form of operation limited to the anterior vaginal wall that has stood the test of time, and of the numerous cures reported in the journals following operations of this character it is more than probable that the conditions antedating operation, in the vast majority of the cases, partook of the characteristics of anterior colpocele rather than that of colpocystocele or of true cystocele.

In some of the milder types of colpocystocele, as it occurs in the comparatively young, a resection of the redundant vaginal structure with detachment and transposition of the vesical base to a higher level (Vol. V., p. 442) may prove of value for the time being, but in order to avoid a recurrence of the condition later in life, and with a due regard for the reproductive function, an operation for the correction of the causal factor (the uterine prolapse) by one of the various methods for intra-abdominal shortening of the round ligaments is likewise indicated.

The greater frequency, however, and the more pronounced and more progressive forms of the abnormality generally met with toward the decline of the reproductive period during and following the climacteric, demand surgical measures that involve not alone extensive plastic resections of the vaginal walls and cervix, but the utilization of the uterus,

now functionally useless, either as a cross-beam or base for the support of the bladder from below by a vaginal procedure, or as a fixed stay for holding up the vesicovaginal septum from above through an abdominal operation.

In cases of colpocystocele complicated by new growths, malignant or inflammatory disease, demanding supravaginal or total hysterectomy (vaginal or abdominal), the upper angles of the broad ligaments become the most reliable fixed points for vaginal attachment in correcting the condition.

VAGINAL OPERATIONS.

Uterine Interposition.—For a description of this operation in its simplest form the reader is referred to Vol. V., p. 444. In my experience this is one of the most scientifically conceived procedures for the

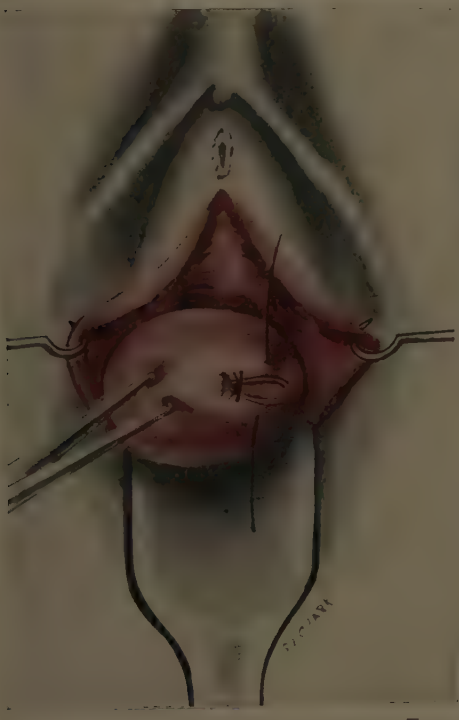

Fig. 393.—Resection of Proximal End of a Fallopian Tube.

Fig. 394.—Partial Excision of Uterus. (Watkins.)

Sutures introduced for fixation of resected organ between vagina and base of bladder.

cure of colpocystocele that has been devised. It gives the best results by the shortest route, the least operative trauma, takes less time to perform it, and with the least risk to the patient, compared with any other method at our command.

If the operation is done during the reproductive period, before introducing the vaginal fixation sutures resection of the proximal ends of the tubes should be performed to prevent pregnancy, as shown in Fig. 393.

In cases of complete uterine prolapse, when the organ is large and the ligaments are much relaxed, Watkins recommends partial excision of the uterus in its long axis. In Fig. 394 a large portion of the anterior uterine wall has been removed. The bleeding in this operation is controlled by ligating the anastomotic arteries on the sides of the uterus. Sutures are introduced through the remaining portion of the uterine fundus, and the vaginal flaps (as shown in the illustration), when drawn taut (upon releasing the cervix), place this portion of the organ beneath the vesical base near the entrance of the urethra. The vaginal wound is closed by introducing stitches that incorporate both vaginal and uterine structures.

In **cases of malignant disease** or other disorders of the uterus requiring vaginal hysterectomy, the associated colpocystocele is best corrected by fastening the cut lateral angles of the vaginal vault to the upper angles of the broad ligaments, as described in Vol. V., p. 497.

In all of these operations restoration of the pelvic floor and posterior vaginal resection, as may be necessary, should be done last.

ABDOMINAL OPERATIONS.

All plastic work on the cervix, vesicovaginal septum, pelvic floor, and posterior vaginal wall, as may be indicated, should be performed before the abdomen is opened.

Ventrofixation of the uterus, or the firm attachment of the fundus of the organ to the hypogastric musculature of the abdominal wall, although the first of the transperitoneal operations for the cure of uterine prolapse and cystocele (colpocystocele), still remains the operation of choice with many surgeons (Vol. V., p. 507). This procedure usually gives very satisfactory immediate results, and while their permanency continues secure in a large proportion of cases, the ultimate failures are by no means numbered among the few. Even with absolute fixation of the fundus the cervix, especially the supravaginal portion, not infrequently undergoes hypertrophic elongation as a result of its relation to the long axis of the vaginal canal, and traction by the vaginal walls with consequent recurrence of the colpocystocele.

If, in addition to the abdominal fixation, however, the organ is placed in a more horizontal position by reduplicating and shortening the relaxed uterosacral ligaments (if accessible and sufficiently developed for the purpose), or by lifting the supravaginal segment of the cervix to a higher level in the pelvis and obliterating Douglas' pouch by suturing the apposed peritoneal surfaces, thus placing the vaginal cervix as high up and as far back as possible in the hollow of the sacrum, at right angles to the vaginal canal, so that the anterior face of the uterine body is again indirectly supported by a properly restored pelvic floor, a still larger percentage of cures by the abdominal route may be secured.

Supravaginal hysterectomy, with fixation of the cervical stump to the abdominal wall, is indicated in cases of colpocystocele depending upon an enlarged prolapsed uterus from any cause, excepting malig-

nancy, associated with extraordinary relaxation of its ligamentous supports.

Fixation of the lateral angles of the cervical stump to the upper angles of the resected broad ligaments may be resorted to in any case requiring removal of the body of the uterus, with good results.

In **cases of malignancy,** or other complications demanding total hysterectomy by the abdominal route, the associated colpocystocele may be corrected by suturing the lateral angles of the vaginal fornices to the upper angles of the broad ligament.

Hernia of the Bladder, or True Cystocele.—True cystocele is a hernia of the bladder through a fascial and muscular defect in the vaginal roof, or, as frequently happens, occurs as a result of atrophy of the entire vesicovaginal septum. The former condition, unlike hernia in other parts of the body, seldom presents any well-defined pillars, while the latter may involve the tissues from the cervical junction to the pubes and from one ramus to the other.

The bulging vaginal mucosa in these cases always is reduced to extreme thinness, and in appearance presents the regular outline and smoothness of a cystic tumor.

An examination with a sound discloses a vesical sulcus that corresponds with the size and situation of the vaginal protrusion. Symptoms of residual urinary retention are frequently present.

The uterus usually occupies a normal position, which in women who have passed the menopause is that of moderate retroversion with slight descent, as compared with the anteverted and more elevated position of the organ during the reproductive period. A lacerated or relaxed pelvic floor usually is an associated complication, and generally bears more or less of a causal relation to its development.

Hernia of the bladder usually occurs in women well advanced in years. It is rare before the advent of the menopause, but is occasionally met with in comparatively young women, and has been observed in the unmarried.

Treatment.—In suitable cases, as indicated on p. 807, the Menge pessary may afford relief.

Of the many ingenious and complicated surgical procedures, both vaginal and abdominal, that have been devised and practised for correcting so-called cystocele, it is more than probable that the reported cures have been in cases of anterior colpocele and colpocystocele, and but rarely in those with hernia of the bladder or true cystocele. True cystocele differs as much from colpocele and colpocystocele as a loose fold of hypertrophied skin or a relaxed abdominal wall differs from a ventral hernia.

The closure of the hernial opening in either situation involves restoration of the fascia and muscle in continuity or transplantation of analogous structures from neighboring parts.

Owing to the absence of a well-defined ring or pillars to serve as guides in estimating the extent of the hernial opening, all operations

limited to the base of the bladder and the anterior vaginal wall necessarily are uncertain in their results, and frequently end in failure.

Uterine interposition, as practised in the treatment of colpocystocele, is the only operation at our command to-day that gives uniformly good results in cases of vesical hernia or true cystocele, and should be the operation of choice whenever practicable. The uterus upon the completion of this operation plugs the hernial opening, while the bladder rests upon its posterior wall. Both uterus and vagina are suspended by the broad ligaments, especially their upper segments, supplemented by the round ligaments. The tension and, therefore, the supporting efficiency of all these structures is enhanced by the extreme forward tilt of the uterus, rendering a recurrence of the cystocele practically impossible.

Restoration of the pelvic floor and resection of the vaginal walls should be done if indicated.

In all cases of vesical hernia or true cystocele complicated by conditions that demand supravaginal or total hysterectomy, either by the vaginal or the abdominal route, extreme narrowing of the vagina or complete closure of the vulvovaginal orifice are the only alternatives.

In the treatment of vesical hernia or true cystocele the formation of a new base of vesical support and closure of the hernial opening by the transplantation of an extraneous fascial plate, making the uterus and the white lines of the pelvis fixed points of attachment for the new structure, is suggested as a field in experimental surgery well worth considering.

Surgery of the Uterus, Broad Ligaments, Fallopian Tubes, and Ovaries.

By E. E. Montgomery, M. D.,
Philadelphia.

Acute Endometritis and Metritis.—The direct implantation of the uterine mucosa upon the muscular layer without an interposed submucous layer renders it evident that severe inflammation of the mucosa could not exist without extension to the subjacent muscular structure. Such extension is still more certain when it is considered that the uterine tubular glands project into the muscular structure. Inflammation of these structures is always produced by infection, and may occur in both the puerperal and non-puerperal uterus.

Etiology.—In puerperal patients infection is promoted by retention within the cavity of blood-clot, portions of decidual membrane, or placenta. The normal clotting of blood in the uterine sinuses may serve for the entrance of infectious germs. The tract may have been infected previous to abortion or labor by a pre-existing gonorrhea, when the process is one of auto-infection. The infectious products, however, are more frequently introduced by the hands of careless or unclean attendants. The non-puerperal infection may be the result

of gonorrhea, or trauma in careless or unskilful manipulation for diagnosis or operative procedures.

Varieties.—The manifestations of infection in the uterine tract are so varied as to enable us to differentiate them into distinct divisions, as sapremic, gonorrheal, septic, and pyemic. Of these varieties the *sapremic* is the most readily controlled, although its onset may appear exceedingly grave. It is the result of decomposition in retained products, such as blood-clot, portions of placenta, or decidual membrane, and arises from the presence of saprophytes. The absorption of products of decomposition produces a condition of putrid intoxication.

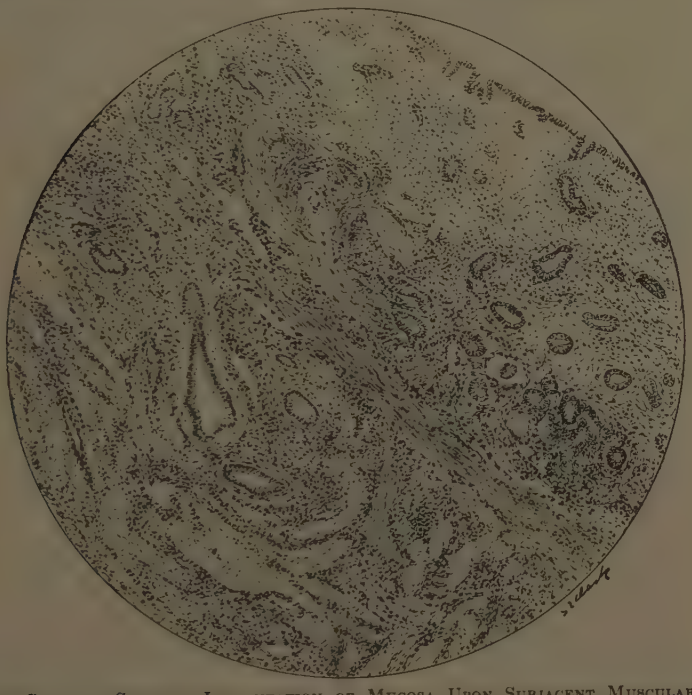

Fig. 395.—Sections Showing Implantation of Mucosa Upon Subjacent Muscular Layer.

Gonorrheal inflammation arises from a recent infection or from the reawakening of a pre-existing infective process. Inflammation produced by either sapremia or gonorrhea may afford a favorable soil upon which a septic process may become engrafted.

Sepsis is far more grave, more difficult to combat, and more destructive in its effects than either of the preceding conditions. It is instigated by the streptococcus, the staphylococcus, or the Bacillus coli communis. The same germs may cause the production of pyemia.

Pathologic Changes.—The alterations to which the structures of the uterus and, thereafter possibly, of the entire body are dependent upon the character and virulence of the infection and on the resistance of the individual. In the sapremic form the changes are in the retained

structures, while the symptoms follow from absorption of the toxins thus manufactured. Gonorrheal inflammation involves the superficial structures. It extends by the continuous and contiguous structures, and results by its extension into the Fallopian tubes, in closure of their abdominal ends, and the formation of inflammatory collections within them. Less frequently it enters the blood-vessels, leading to the development in the joints of a form of arthritis.

Septic infection becomes implanted on the mucosa, and when virulent may extend upon the continuous surface, but more frequently proceeds by the blood-vessels and lymphatics. As a consequence, it shows less inclination to localization and may result in very grave general infection. The pyemic variety, so far as we know, due to the same micro-organisms, possibly slower and more insidious in its onset, sud-

FIG. 396.—MILIARY ABSCESS FORMATION IN THE UTERINE SINUSES.

denly indicates its presence by secondary manifestations in joints and remote portions of the body.

Symptoms and Physical Signs.—See Vol. V., p. 462.

Course and Progress.—The local manifestations in some cases may be exceedingly slight, or due to the decreased virulence of the infection or the lessened susceptibility of the individual, the disease involves the general system with slight if any local influence. In other cases local pockets of infection may be the foci for further distribution. In such cases the uterine sinuses form the favorable soil for the multiplication and distribution of the pathogenic organisms. Not infrequently one or both sides of the uterus will be the site of numerous miliary abscesses whose intermediate barriers break down and form large abscess cavities. In other cases the sides of the uterus and the broad ligaments become extensively involved. Nature, in her efforts to pre-

vent the extension of the organisms by round-cell infiltration, forms extensive barriers which, in turn, break down under the onslaughts of the infective process. In many cases the inflammation penetrates the uterine wall and involves its peritoneal surface. The inflammation may reach the peritoneum thus, directly, or by the course of the Fallopian tube. Peritoneal inflammation may be slight or very extensive. I have seen the entire surface of the uterus covered over with plastic exudate. The process may pass through the lymphatics, producing lymphangitis, and lead to secondary manifestations and degenerations in the lymphatic glands.

FIG. 397.—TUBAL COLLECTIONS WITH FIXATION OF THE UTERUS.

In pyemia the disease may be slower in its development, and suddenly, without warning, the patient have a severe chill or repeated chills, and complain of pain in portions of the body remote from the seat of original infection. Such a manifestation may be in the form of an acute inflammation of one of the larger joints, which may go on to suppuration. The subsidence of the inflammation in the affected part may be followed by a repetition of the symptoms, with the production of a suppurative process in some other portion of the body. The intervals between these exacerbations will be attended with night-sweats, progressive weakness of the pulse, continued elevation of temperature, loss of appetite, and gradual loss of strength. In the distinctly septic process, miliary abscesses may lead to breaking down and sloughing of

extensive portions of the uterus, or the collection may be walled off, forming a distinct abscess-cavity. Where the localization takes place in the Fallopian tube it may form a large sac, or, as the ovary blocks the end of the tube, the former may become infected and develop tubo-ovarian abscess. Occasionally the tubes, from their weight, drop down into Douglas' pouch, become walled off, and, either through leakage, transudation through the sac walls, or rupture, form a large collection posterior to the uterus. As has been mentioned, the increased virulence of the infection and decreased resistance of the patient are factors which may lead to rapid systemic infection, and death of the patient before any local foci have been formed.

Diagnosis.—The early recognition of the form of infection and the methods of its determination, as set forth in Vol. V., p. 463, cannot be too strongly emphasized. The pyemic form may be unsuspected until repeated chills and remote local manifestations arise. An early blood examination is important, not only for the purpose of determining the particular organisms, but for eliminating the possibility of other forms of infection, and for determining its virulence and the antagonism or resistance of the individual as shown by the leukocytosis.

Prognosis.—Sapremic infection is the least formidable, although at its onset it may appear exceedingly grave. The condition may occasionally subside spontaneously through the expulsion of the putrid and decomposed masses by uterine contraction. The mechanical removal of the products results in an almost immediate subsidence of the grave symptoms. In a few instances the manipulation necessary for the removal of the affected structures is followed by elevation of temperature, but such an exacerbation is of short duration. In one instance, where I had assisted in the removal of such affected tissues, I was called later to see the patient with a temperature of 106° F., but it soon subsided without special treatment.

Gonorrheal infection, while more serious than the sapremic, is a superficial inflammation. It leads to more extensive inflammatory reactions, with changes which may cripple or handicap the patient in the performance of the functions of the organs affected. Unless the resistance is greatly diminished it is unlikely to have a fatal effect.

Septic infection is one of the gravest of disorders, and may have become implanted upon the soil prepared by the saprophytic and gonococcal organisms. It rapidly enters the body through the blood-vessels and may produce disordered conditions in different portions of the body, developing the condition known as pyemia, or it may so rapidly overwhelm the constitution of the patient as to lead to a fatal termination without any apparent local conditions. Generally, in sepsis, the vulva and vagina are swollen, and fractured or injured surfaces are covered with an exudation. Occasionally, from the vulva as a center an erysipelatous wave or blush may spread over the entire body. In other instances the infection invades the deeper structures, resulting in local pus collections in the uterus, tubes, ovaries, and their environment. The more active the progress and the feebler the resistance, the

more grave the outlook. Where death does not take place the destructive influence upon the affected organs leads to their crippling, loss of function, and in many instances necessitates their sacrifice in order to obviate a fatal termination or render continuation of life endurable. The disease is limited by the virulence only of the micro-organisms or the resistance of the patient's tissue. It is impossible to prognosticate with any certainty when it will have run its course. A patient who is apparently convalescent may develop serious phlebitis, which subsequently terminates in death from embolism, or in protracted discomfort and ill-health from obstructed vessels. A favorable termination is indicated by gradual reduction of temperature, lessening of the frequency of pulse, and improvement in the nutrition and strength of the patient. Recovery may leave the patient with a uterus in which there is substi-

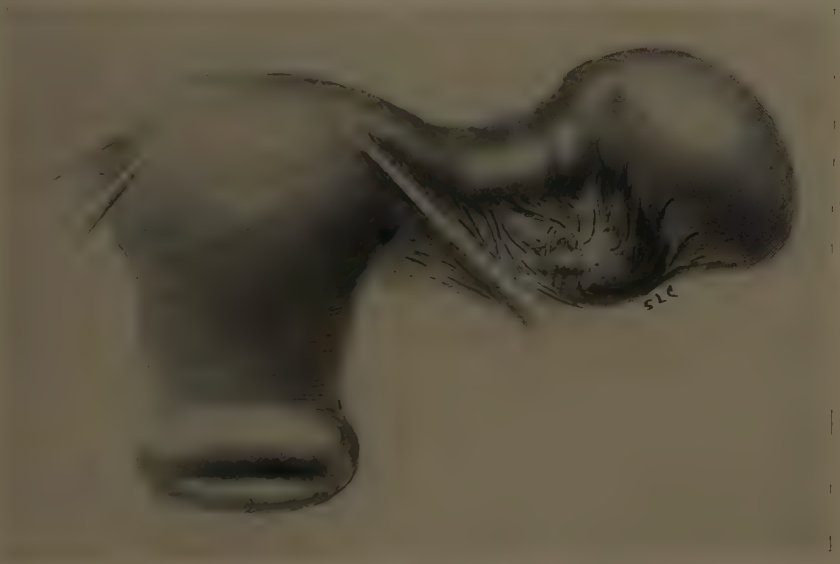

Fig. 398.—Pus-tube.

tution to a large degree of fibrous or cicatricial tissue for the normal muscular structure. Fallopian tubes obstructed or closed, containing serum, blood, or pus, adherent or fixed uterus, tubes, and ovaries are conditions which render these organs unable to perform their functions, or when doing so in part, is attended with severe pain and distress and leads to subsequent complications. Collections of pus may be walled off in the parenchyma of the uterus in the anterior or posterior cul-de-sac or within the Fallopian tubes. Such collections may remain apparently quiescent without producing marked constitutional disturbances, and suddenly result in a severe flare-up or exacerbation which may again place the life of the patient in danger.

Treatment.—Necessarily, the study of the disease process has demonstrated the importance of adapting treatment to the particular

variety under consideration, and for this purpose its character must be recognized. The saprophytic form is indicated by the profuse and offensive lochia and by finding within the uterus some decomposing mass. Of course, in this and all varieties the most effective treatment is the prophylactic, and the nearer the obstetrician can imitate or follow the methods of the surgeon in the practice of asepsis and the removal of all foreign material, the less likely will there be any subsequent disorder. The existence of such conditions, however, demand prompt measures, first, to remove offensive and decomposing products; second, to combat the progress of the infection, and, third, to promote the patient's resistance. Where the uterus is clear and contains no extraneous material, the employment of the curet or manipulation of the uterine cavity is not only ineffectual, but deleterious. The infection has already passed through the mucous membrane and is beyond the reach of such measures.

Cleanliness is not detrimental, and where the uterine canal is sufficiently open to permit ingress without trauma, irrigation with hot sodium chlorid, sodium bicarbonate douches, or weak solutions of iodin may be of value. Inflamed lacerations of the vulva and vagina may be touched with strong carbolic acid and the vulva should be kept covered with an aseptic pad. The patient should be closely confined to bed and not permitted to rise. An ice-bag, or one upon either side, should be kept constantly applied while the inflammation is acute. The bowels should be kept open without free purgation. The diet should be easily digested and of such a character as will afford the greatest amount of nutrition with the least expenditure of effort. Marked elevation of temperature should be controlled by cold sponging, the pack, or the cold plunge. Antipyretics should be strictly avoided, as the elevation of temperature is an evidence of the resistance of the tissues of the patient against further contamination. The more effectually the patient can be aided in her manufacture of immunizing products in her blood, the more quickly will the course of the disease be arrested. For this purpose the various vaccines and serums have been employed, but as yet with not altogether satisfactory results. It seems to be the opinion of those who have employed them that in the acute condition the vaccines are less effectual than are the serums. The great difficulty in their employment lies in our inability to determine the character of the infection in order to employ the proper serum or vaccine. As it requires some length of time and special measures in technic, which are not always at the command of the attendant, it is preferable to employ the mixed vaccines or serums. It is a question whether the failure in the employment of these agents has not been due to the timidity of the investigator in the quantity of the agent employed. In my experience not less than 20 c.c. of the antistreptococcic serum is likely to be of benefit in serious cases, and in the employment of the vaccines 20,000,000 to 200,000,000 of the dead bacteria should be given, according to the virulence of the condition. Various antiseptic agents have been employed by intravenous injection for the purpose of combating the

poisonous effects of the toxins or the destruction of the micro-organisms. Unfortunately, such measures are not infrequently the cause of further disorganization in the corpuscular structures of the blood. The agents which have been employed for this purpose have been formalin, carbolic acid, and the mercurial salts. If employed, these agents should be given greatly diluted—the strength of 1:50,000 to 1:20,000 of formalin.

Carbolic acid should not be given intravenously. Mercuric bichlorid or the mercuric biniodid may be given ($\frac{1}{8}$ gr. dissolved in a pint of distilled water); in the case of the biniodid it will be necessary to add a few cubic centimeters of a saturated solution of potassium iodid in order to dissolve it. The administration of a 1 per cent. solution of magnesium sulphate in a normal salt solution has been found especially effective in the reduction of high temperature and in shortening the period of febrile reaction. Just what is its *modus operandi* does not seem to be determined. The progress of the affected patient should be carefully followed and frequent investigation made to discover evidences of localization. The evidence of a collection of pus is an indication for its evacuation. Such a collection may be reached by incision through the anterior, posterior, or lateral fornices of the vagina. If the collection is situated high up on one side of the pelvis, especially when involving the cellular tissue, it may be reached by an incision above Poupart's ligament by pushing off the parietal peritoneum. When the collection involves a tube and ovary, an abdominal incision should be made and the affected structures removed. When pus collections involve tubes and ovaries on both sides, the appendages as well as the fundus of the uterus should be sacrificed. When the examination reveals that the uterine wall and the broad ligament are broken down, hysterectomy should be done. In such cases, especially when the broad ligaments are the seat of multiple abscesses, the vessels should be isolated and ligated rather than to tie the ligament *en masse*, as the drainage from the infected structures will be more effectual. In cases of peritonitis an early incision through the posterior fornix of the vagina should be made and a gauze drain inserted. The infection can be rapidly washed out in such cases by the employment of the Fowler-Murphy rectal instillation of salt solution. The patient should be elevated in a semisitting position, as suggested by Fowler. In extensive suppurative peritonitis it may be wise to make an opening over either flank, another in each lumbar region, and, finally, one in the posterior fornix of the vagina, and connect these with ropes of gauze.

In cases of extensive peritonitis it is unwise to do an extensive operation, the motto of the operator should be, "Get in and get out" as quickly as possible, trusting to drainage and proctoclysis to secure the evacuation of the pus collection. Indeed, this instillation of salt solution cannot be overvalued at any stage of the procedure. In the early stage of inflammation, prior to an incision, it promotes the more rapid elimination of the toxin products through the active stimulation of the kidneys and the skin, and in cases in which the patient is unable

to retain the solution it can be made effective by introducing a rectal cannula with two tubes attached, one for the ingress of the solution and the other for its exit, which will carry off the superfluous fluid to a basin at the side of the bed, while the retention of a larger quantity of the fluid can be effected by elevating the pelvis. The colon gradually fills and a large quantity of the fluid is absorbed, filling the blood-vessels and greatly promoting the patient's power of elimination.

A careful comparison of the quantity introduced and that eliminated by the renal secretion should be kept, for where the latter is deficient the peritoneal cavity becomes filled, and the patient is water-logged and oppressed by the accumulation.

The convalescence of the patient must be carefully watched, as the mere subsidence of temperature and amelioration of symptoms do not necessarily mean that all goes well. Sir William Sinclair emphasizes

Fig. 399.—Destruction of Fundus Uteri by Abscess Formation.

this when he says, " Much harm may be done in the pelvis with a temperature below 100.4° F., and without sufficient quickening of the pulse to attract attention," and states the following reasons for failure in their recognition: " 1. The ordinary midwife makes no observations. 2. Monthly nurses belong to the same class, and careful and experienced physicians can see the patient but once a day, and even in hospitals such conditions are overlooked. What are the indications which should make him suspect danger? A slight chilliness without rigor, an accelerated pulse-rate when it should be slow, a slight and not evanescent rise of temperature sometimes during the twenty-four hours, as shown on a four-hour record, symptoms which may be satisfactorily explained by the report of the nurse that the baby was fractious, the husband a little unkind, or the breasts a little too full. Such symptoms should have awakened the suspicion of a slight form of lymphatic sepsis. The

patient should never be considered out of danger so long as the temperature and the pulse-rate are above normal." Years ago, in the Philadelphia Hospital, I ignorantly but complacently watched a woman who had a severe attack of puerperal sepsis, whose temperature was rarely 100° F., but in whom the pulse-rate was continually above that mark, suddenly, at the end of a week, go into collapse and die. Autopsy disclosed that the entire fundus of the uterus had been destroyed by miliary abscess formation.

The recovery of a patient after a severe attack of sepsis is not always a complete one. Destructive processes so great as to demand operation may result in partial or complete loss of function. If operative treatment has not been resorted to, sterility may have been occasioned by tubal closure, enveloping the ovaries with plastic exudate, preventing the escape of the ovum, or the uterus with these structures may all be enveloped and fixed in a mass of exudate. Such conditions are responsible for many of the cases of sterility known as one-child marriages. The substitution of cicatricial for muscular structure in the uterine walls with the consequent changes in the endometrium unfit the uterus for the reception and maintenance of the fetus, so that abortion is frequent where conception occurs. The treatment of the condition should be followed to render the effects as little distressing as possible. Involution should be promoted, displacements corrected, lacerations repaired, and adhesions broken up before they become dense and firm. Much can be done for patients by tampons, douches, pelvic massage, proper baths, and judicious exercise.

Endocervicitis.—(See Vol. V., p. 464.)

This condition, also called *chronic cervical catarrh*, is generally regarded to be the cause of the condition known as *erosion*. The peculiar appearance of the cervix engendered by the latter is ordinarily regarded as the result of a profuse acrid discharge from the cervical canal. The erosion exhibits a flat, raw, sometimes discolored surface around the external os, projecting most frequently to a greater distance upon its posterior surface. In the multiparous woman it is often associated with laceration of the cervix and eversion of the cervical mucous membrane. Erosion was formerly regarded as an ulceration, but microscopic investigation shows a thickening of the papillæ covered with a single layer of epithelium. Willett Cunningham asserts, with which statement Gottschalk and Bell coincide, that it is a flat adenomatous growth. Gottschalk says, "It is characterized by irritation, loss of epithelium, and enlargement of the cervical glands." He notes the following changes in cell structure: "(1) Subepithelial extravasation of blood; (2) copious round-cell infiltration; or (3) rupture under pressure of retention cysts arising from such cervical glands. Nude surfaces become covered with cylindric epithelial cells with vibratile cilia arising from the ectopic cervical cells. In a later stage, newly formed stratified squamous epithelium pushes off the cylindric epithelial cells and sends strong papillæ deep into the connective tissue, crushing the ectopic glands. The contest between the forms of epithelium is an unequal

one, as the victory is usually with the squamous, and there is always danger of malignant change."

Cunningham attributes to it the following symptoms: "Pain in the back over the lumbar vertebra, which will often be tender as well. This pain and tenderness are generally increased by long standing and extend down the limbs. The ovarian regions are also generally painful. A profuse vaginal discharge, white or yellowish in color, is usually present and is frequently tinged with blood. Married women often complain of dyspareunia. The pain is aggravated by the approach of menstruation and by constipation. The discharge is frequently irritating to the external genitalia, and may be the cause of onanism in the young. The condition is quite common in unmarried women and requires local measures for its relief. The surface is most readily cleansed by mopping it with a strong solution of sodium bicarbonate. If the condition offers a suspicion of malignancy a section should be removed for microscopic investigation. It should be differentiated from lacerated cervix."

FIG. 400.—REMOVAL OF CIRCULAR WEDGE-SHAPED SECTION OF THE CERVIX BY AMPUTATION FOR EROSION.

Treatment, after cleansing the surface, consists in applications of iodized phenol, 10 per cent. solution of protargol, or 20 per cent. solution of copper sulphate. Where the erosion is persistent and extensive it is sometimes advisable to remove a wedge-shaped section from the end of the cervix, if necessary completely encircling it. The important consideration in the treatment of all inflammation of the cervix is to insure good drainage. In some instances the external os is small, presenting what is known as a pin-hole orifice, while the cervical canal above it is dilated. The mere dilatation of such a cervix will soon be followed by recontraction. The better plan of procedure is to incise the cervix transversely and again at right angles to this, cut out the intermediate portion, and suture the cervical mucosa to that covering the external surface.

Chronic Endometritis.—In the discussion of chronic inflammation of the endometrium the pendulum has swung backward and forward since the day that Bennett first described it. Bennett and his followers were strong advocates of its existence. Other careful students have been just as strong in their opposition. Grailey-Hewitt attributed

to uterine displacement all the symptoms that are commonly accepted as the result of inflammation. Emmet ascribed these symptoms to congestion of the uterine mucosa resulting from obstruction of the circulation through peri-uterine inflammation. At present Theilhaber, Lofquist, Hitschman, Gottschalk, Ehrenfest, and others deny the existence of chronic endometritis. They assert that all the pathologic changes ascribed to the various forms of endometritis are to be found in the changes corresponding to the increased and lessened congestion associated with each menstrual cycle. They do not agree with the recent investigators who deny desquamation of the epithelium with each menstrual period. They describe a swelling of the epithelium which takes place as a preparation for the approaching menstruation. This spongy condition of the epithelial layer later results in its death and disintegration when the cells thrown off are in shreds, or even in casts of the uterine cavity.

Ehrenfest has described under the title *endometritis exfoliativa* a condition in which a patient of his discharged with each menstrual period a membranous cast which was at first assumed to be an indication of impregnation. As it continued at each menstrual period without pain or other abnormal symptoms, it was investigated and found that the superficial epithelium was preserved in all sections. The epithelium was usually cylindric with a nucleus in the middle of each cell. Some were found cuboidal. There were evidences of subepithelial hematoma presenting erythrocytes in various stages of degeneration. This extravasation of blood frequently detached the surface epithelium for a long distance. The detached epithelium showed an indistinct contour of its cells, evidently indicating a process of degeneration and beginning necrosis. In the stroma of the cast were found a large number of extravasated erythrocytes and mononuclear and polynuclear lymphocytes. In its superficial parts the glands were narrow, rather straight, and further apart than in the normal non-menstruating endometrium. In the deeper portions, which are rarely seen, the lumina of the irregularly shaped and indented glands lying near to each other in the interglandular tissue were lessened. These observations compare well with the picture Hitschman and Adler draw of the changes in the endometrium preparatory to menstruation, but differ from theirs in that they never found the superficial epithelium, and attributed it to a prior stage of menstruation. Hitschman and Adler thought the epithelium would have been lost later through the process of necrosis caused by its separation over the hematoma. The inference then would be justified that instead of these membranes being the result of acute or chronic inflammation, they are an exaggeration of a physiologic rather than a pathologic process. Hitschman and Adler attribute the desquamation to an unusually marked development of a spongy layer produced by the secretion of the ovaries as indicated by Halban. The separation occurs through the contraction of the uterus, and the more marked the layer, the greater the separation. Ehrenfest attributes the separation to the blood-extravasation beneath the layer, the spongy layer forming the line

of least resistance. Notwithstanding the views of these gentlemen, there are changes of a more protracted character than are explainable by the changes of menstruation. It is doubtless true there are many conditions characterized by local symptoms which simulate inflammation that are produced by constitutional conditions. It cannot be denied that endometritis occurs with much less frequency than is ordinarily considered.

Mundell says, "Chronic endometritis is comparatively rare." Kelly found it in but 2 per cent. of 1000 cureted cases, and of 1770 cases operated on in the Pennsylvania Hospital, but 216 cases had endometritis (1.22 per cent.).

One of the most important results is sterility.

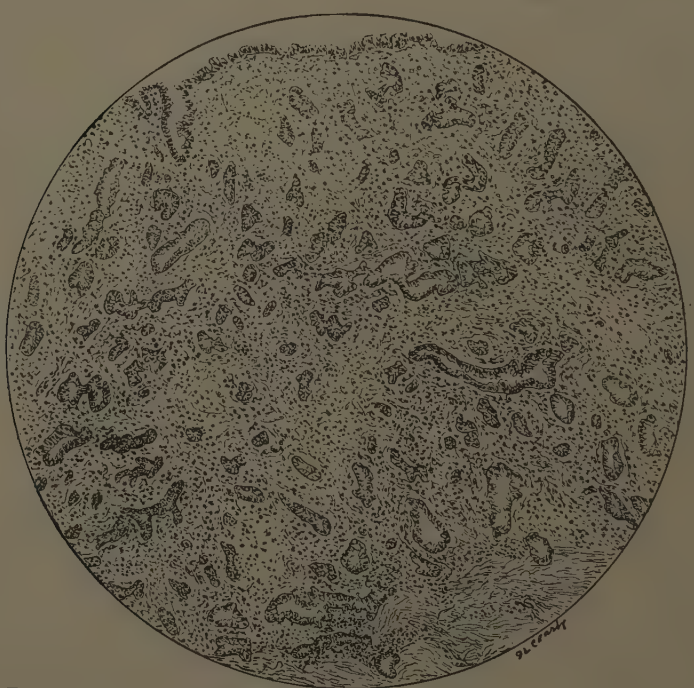

Fig. 401.—Catarrhal Endometritis, Showing Tortuous Tubular Glands.

Etiology.—Ewald, in discussing its etiology, divides chronic endometritis into two groups: First, where the condition is of non-bacterial origin; and, second, due to bacteria. The latter is often secondary to disease of the adnexa, myomata, and cancer. It is most prevalent during menstrual life. He described the mucous membrane microscopically as thickened sometimes to 1 cm. It is soft, velvety, pinkish, with yellow spots intervening, and occasionally presents polypi with slender or broad bases. Ewald, like Ruge, divides the inflammation microscopically into three forms: (*a*) glandular, (*b*) interstitial, and (*c*) diffuse; the latter a combination of the other two. The endometritis of bacterial

origin is attributed (A) to gonorrhea, although it is difficult to recognize the gonococcus; the endometrium becomes 4 or 5 mm. thick, is rough, covered with villi, and attended with a profuse, purulent, and serous secretion; the interstitial tissue is principally affected. (B) Tuberculous endometritis, which is generally secondary to tubal infection and more particularly involves the corpus uteri. Menge describes two forms. In one, small miliary tubercles appear in the mucosa beneath the superficial epithelium, which soon undergo caseous degeneration, and, combining with those adjacent, form superficial ulcers. In the other form a diffuse extravasation into the endometrium occurs, followed by necrotic degeneration of its superficial tissue. (C) Putrid

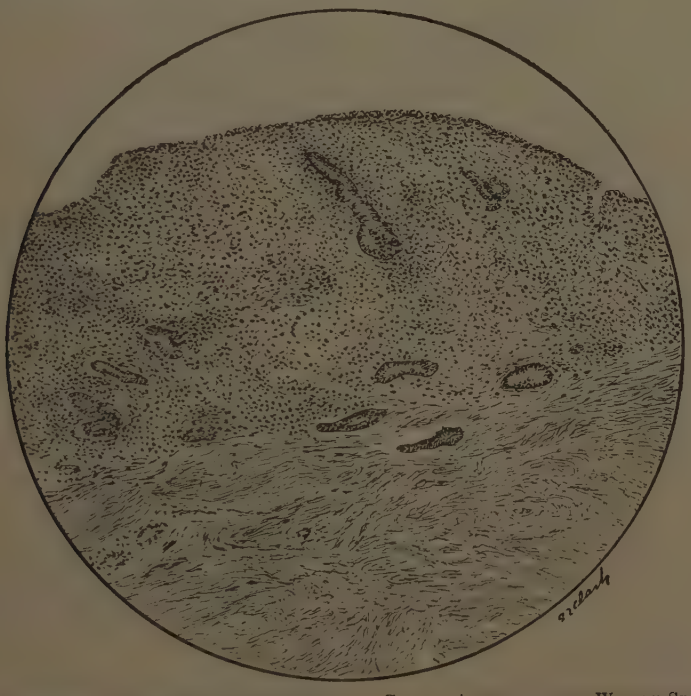

Fig. 402.—Section of Interstitial Endometritis. Glands Atrophied and Widely Separated.

endometritis, in which tissues become infected from retrogression of cancerous or myomatous structures, or from infected instruments. The micro-organisms responsible are the staphylococci, streptococci, and the saprophytes. In this form the endometrium may be replaced by a pyogenic membrane. (D) Septic endometritis after labor or abortion. (E) Decidual endometritis from a local infection, as gonorrhea, which occurs about the fourth month, and is limited to the decidual vera and serotina.

Symptoms and Diagnosis.—(See Vol. V., pp. 467, 468.)

Treatment.—We need not repeat the advice given in Vol. V., p. 468, as to drainage and the correction of malpositions and lacerations.

Kolischer has given some valuable suggestions for the treatment of the gonorrheal form, which I think it well to present. He says that any treatment must meet two main desiderata: First, eradicate the infection; second, stop the abnormal discharge. The intra-uterine applications must be of such a character that they will neither extend the inflammation nor excite that which already exists in them. He analyses 43 cases, in which 4 discontinued the treatment before its completion, 7 could not be found after they were discharged cured, 3 became reinfected, and the remaining 29 were cured. The agent to be employed must be strongly germicidal, capable of producing desquamation of the epithelium without causing an eschar. Frequent applications are de-

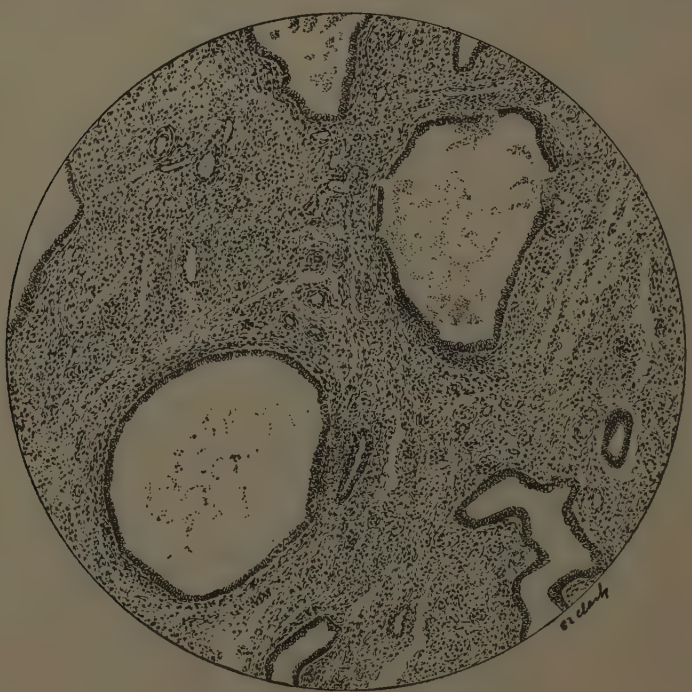

Fig. 403.—Polypoid Endometritis.

manded, and where an eschar has formed the subsequent applications only affect the crust. The first application must be carefully made in order to avoid uterine reaction. The sensibility of the uterus may be determined by slowly introducing a sound anointed with glycerin until it reaches the fundus. Where the uterus is irritable, these soundings will be painful, cause contractions, and should be repeated until they can be done with comparatively little pain before actual treatment is practised.

In the treatment the cervix is exposed by a bivalve speculum. The portio vaginalis and surrounding parts are cleansed by irrigation or swabbing, as follows: The uterine cavity and the cervical canal are freed

from mucus by wiping their surfaces with a saturated solution of sodium bicarbonate; if an applicator with this solution is left in the uterus a minute the mucus will be expelled as a plug. The uterus steadied, but not displaced by a tenaculum, is swabbed with a 3 per cent. solution of albargin, and the applicator carrying it is allowed to remain for five minutes, and following its withdrawal an ichthyol-glycerin tampon is placed beneath the uterus and allowed to remain until the following morning. A hot douche should follow its removal and another treatment be instituted. A slight bloody discharge generally follows this treatment in a few days, but has no detrimental influence. The treatment should be continued daily until the discharge ceases and examination of the secretions fails to disclose either pus or gonococci. In torpid cases, where the albargin is not sufficiently stimulating, it would be well to use occasionally an applicator with a 40 per cent. formalin solution, to be followed with a large ichthyol tampon to protect the vagina. It is exceedingly important that reinfection should be avoided.

Tuberculous endometritis is rare. Bland-Sutton reports a case occurring in a spinster of forty-six years from whom the uterus was removed for hemorrhage, and the examination of the specimen disclosed a mass which proved to be tuberculous. Professor Roberta Allessandri asserts that tuberculosis of the female genital organs instead of being rare is frequent, as he further states that the tubes are most frequently affected. I am inclined to agree with him. He directs attention to the miliary form, which sometimes extends to the ovary and the serosa of the uterus and the pelvic peritoneum. Tuberculosis of the uterus is much more rare and may affect the cervix or body. The infection may be directly introduced through coitus, or by metastasis through the blood. I believe, however, it more frequently occurs by transmission from the Fallopian tubes. I have reported a case in which the disease is confined to the myometrium and had originated there, and was probably transmitted by the blood-vessels. Tuberculosis of the uterus, like carcinoma, should be considered as an indication for extirpation of the affected organ.

Chronic metritis may be a direct sequel of acute inflammation in the uterine mucosa and wall. It is a more frequent complication of long-continued or chronic endometritis, and of peri-uterine inflammations and uterine displacements by which the circulation in the uterus is obstructed. It is a final stage of subinvolution of the uterus. The uterus is large, at first flabby, and later dense and firm; so hard and resisting is it as to simulate myomatous growths.

Etiology and Symptoms.—(See Vol. V., p. 469.)

Hemorrhage is a very persistent symptom. Various changes in the structure of the uterus have been assigned as its cause. Chalfant remarks that it was formerly ascribed to disease of the endometrium, while later investigations demonstrated that the changes attributed to the endometrium are similar to those which occur with each menstruation, and that the hemorrhage was due rather to a disordered condition of the blood-vessels or defective action of the uterine muscle. He

credits Findley, of Omaha, as being one of the first to recognize this in an article entitled *"Apoplexia Uteri."* He attributes the hemorrhage later to muscular insufficiency, and this to an older growth of fibrous tissue which took place both between the muscle-bundles and about the arteries. Anspach demonstrated that this increase was largely elastic rather than fibrous, and regarded the tissue as more physiologic than pathologic, and attributed the hemorrhage to a lack rather than an excess. Goodall has shown that the uterus grows a new set of arteries after every pregnancy. Where the vessels are large, as in the placental sac, the new vessels may grow into the old, and these later become incorporated as a part of the wall. The unutilized portions undergo hyaline degeneration and are absorbed. Where these processes are disturbed, the muscularis of the old vessels, after the hyaline change, may be found to be replaced by elastic tissue.

Chalfant says the arteries all show increase of elastic tissue, particularly around the vessel, but is unable to trace any connection between the absence or presence of this elastic tissue and the occurrence of hemorrhage. He suggests as the immediate cause of hemorrhage, first, an increase in the size and number of blood-vessels; second, a general increase of blood-pressure from kidney disease or general arteriosclerosis; third, local, acute congestions; fourth, anything that causes general or local loss of muscular tone. Theilhaber particularly emphasizes the importance of muscular contraction for the control of hemorrhage, and regards the latter as often due to muscular insufficiency. It may result from muscular atony, and is particularly manifest when there is a lack of proportion between the blood-content and the development of the uterine muscle. In 62 cases of hemorrhage in persons under nineteen years of age the uterus was found to be small in 58 and of normal size in 4 only. An undersized uterus with excessive hyperemia will entail hemorrhage when aggravated by sexual excitement. Masturbation is extraordinarily prevalent in the years of development. The uterus accommodates itself poorly to frequent sexual excitement. The use of inordinate quantities of meat and indulgence in alcohol are liable to induce congestion, and thus entail hemorrhage. Such cases are cured by correction of the bad habits.

Treatment.—It is important that the general condition of the patient should be known. In the majority of cases these hemorrhages occur near the middle period of life, and not infrequently they are due to conditions outside the uterus, a result of increased arterial tension. In such cases, and also in those in which there is muscular insufficiency from fibrous change in the uterine walls, it must be evident that ergot and the allied oxytoxics would be contraindicated. In the first class they increase the arterial tension and consequently aggravate the hemorrhage. In the second class they are useless because the muscular structure is insufficient to be effective. Medical measures consist of rest, depletion, and reduction of arterial tension, tampons, and counterirritants, with a view of diverting the current of blood to other portions of the body. The curet will ofttimes serve a useful purpose.

Malpositions of the uterus should be corrected and processes of metabolism established by amputation of its cervix.

Where the metritis has long existed, the uterus is unfitted for the purpose of procreation, and the question of its extirpation may be a proper subject for consideration. In women near the climacteric the wisdom of such a procedure is often indisputable, but earlier in life the long, protracted, and frequently severe vasomotor disturbances arising from the removal of the uterus and its appendages makes the procedure questionable. Even in those cases in which there is tubal inflammation which would preclude the possibility of conception, the wiser plan would seem to be the Kiel-shaped incision of the fundus, including the Fallopian tubes, leaving the ovaries and a sufficient amount of the uterine mucosa to insure the continuance of menstruation, as has been suggested by Doran. R. R. Smith has reported 23 cases of subinvoluted uterus treated by hysterectomy in which the youngest patient was thirty-five and the oldest fifty-five years; 9 were losing blood enough between the periods to make their condition serious, while 5 had profuse bleeding. In 9 the flow was practically normal, but they were suffering from marked pelvic discomfort. In 12 the position of the uterus was practically normal, while in 6 it was retroverted; in 4 there was a tendency to prolapsus, and in 1 it was quite marked. These cases were without mortality and all were subsequently free from symptoms attributable to the condition. He presents as indications for the operation: first, long continuance of the symptoms; second, severe loss of blood; third, non-relief by simple procedures; fourth, the age of the patient, fifth; the size and condition of the uterus. On p. 471, Vol. V., will be found a careful description of the technic for curetment. I would suggest that the preparation of the patient for this procedure be simplified as follows: The patient to be shaved the day before the operation, and given a thorough bath, in which special attention is devoted to washing the genitalia. No douche or vaginal preparation should be made prior to coming to the operating-table, when, after anesthesia, the vulva, vagina, and anus are thoroughly scrubbed with alcohol, the external os and cervical canal wiped out with the same, after which the cervix, wall of the vagina, and vulva should be swabbed with tincture of iodin. Following the operation a light iodoform gauze packing should be placed in the vagina to remain for twenty-four hours.

I have already suggested the advisability of hysterectomy in women with large uteri associated with profuse bleeding. This advice is satisfactory where the woman has reached an age in which the climacteric should be expected soon, but in women who come under observation on or before the thirty-fifth year the vasomotor disturbances associated with a premature climacteric after hysterectomy are often so stormy as to lead the patient to regret that she had submitted to an operation, and in some cases it produces such a psychologic impression as to render her mentally unbalanced. To avoid such possibilities it seems wiser to do a supravaginal operation, or even an excision of the uterine fundus in such a way as to retain a sufficient amount of the

mucosa to continue the menstrual functions. Such an excision should remove both tubes and be carried across the fundus of the uterus, as

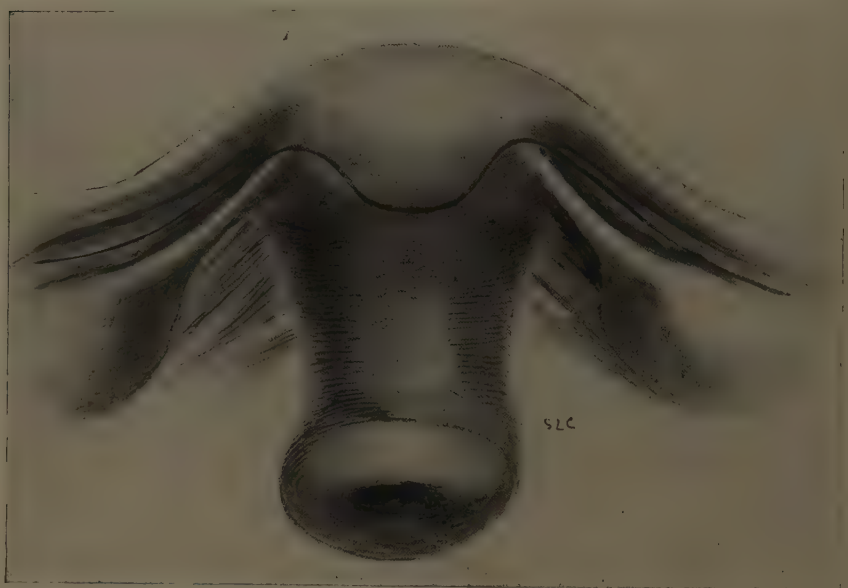

FIG. 404.—OUTLINE FOR KIEL-SHAPED EXCISION OF THE FUNDUS AND FALLOPIAN TUBES, HAVING THE OVARIES AND SUFFICIENT UTERINE MUCOSA TO CONTINUE MENSTRUATION.

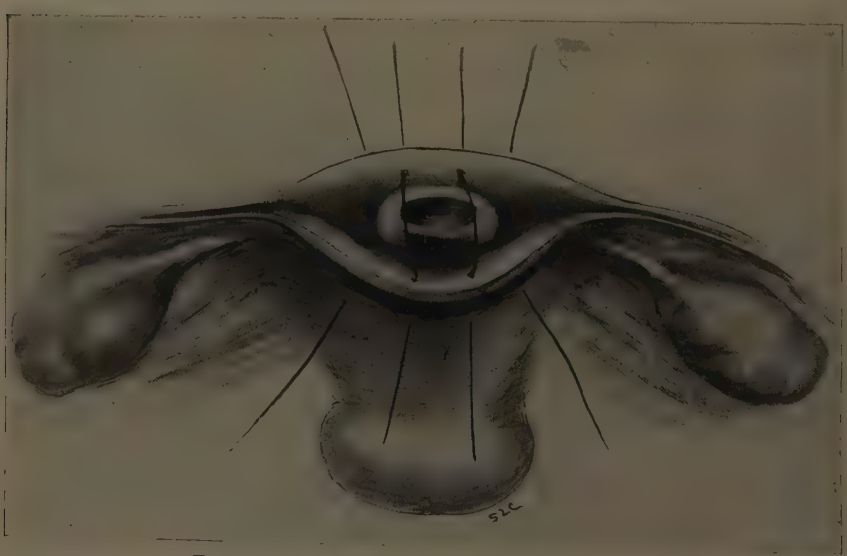

FIG. 405.—AFTER EXCISION OF FUNDUS IN FIG. 404.

outlined in Fig. 404, so that when completed, as shown in Fig. 405, the ovaries and round ligaments will be retained, while the tubes and fundus are sacrifiecd. The metabolism thus set up in the portion of the

uterus remaining renders menstruation less likely to be associated with pain, and there is not surface sufficient left from which bleeding may take place. The retention of the round ligament serves to hold up the rudimentary organ and lessen the danger of prolapsus.

Cesarean Section.—On p. 485, Vol. V., various procedures have been described which were devised for the purpose of performing Cesarean section without entering the peritoneal cavity. Schauta, in reviewing these alternative procedures, quotes Sellheim as giving the following disadvantages for the classic method: First, the great danger of injuring the intestines; second, the increased hemorrhage; third, the possibility of establishing a culture collection in the peritoneal cavity from the discharge of blood and amniotic fluid; fourth, the danger of introducing infection into the peritoneal cavity; fifth, the danger of forming adhesions between the omentum and intestines and the uterine wound; sixth, the fixation of the uterus in the abdomen by adhesions of the wound surfaces; seventh, the possibility of the scar undergoing stretching and endangering rupture of the uterus in a subsequent pregnancy; eighth, the frequency of the appearance of abdominal hernia; ninth, the danger of asphyxiation of the child from manipulation of the uterus, and tenth, the necessity for so-called ligation of the cord.

Advantages which are claimed for the cervical method were, first, the possibility of the evacuation of the uterus *in situ;* second, the physiologic separation of the placenta; third, the possibility of the employment of the transverse incision of the fascia, to which Küstner cited an additional advantage, the trifling danger of air-emboli in the after-birth period. These advantages, when considered, prove to be more apparent than real. The loss of blood in cervical section is trifling, it is true, except in separation of the peritoneum, when it is sometimes very serious. The hemorrhage at the time of opening the uterus in the classic Cesarean may be severe, but the firm contraction after the delivery of the child controls it more effectively than in the thin cervical incision. The danger of infection to the peritoneal cavity is nil in non-infected cases, and this method should not be employed in patients who are infected. The entrance of blood and amniotic fluid is unnecessary when proper protection is given, but should it occur, the collection can be easily removed. The omental and intestinal adhesions belong to the cases in which there has not been proper asepsis.

Stretching and tearing of the scar are exceedingly rare where proper suturing has been done. The transverse incision of the fascia can be practised with the classic section. The objection that prolonged manipulation causes asphyxia is not a valid one, as greater manipulation is required for the extraperitoneal method. Fetal asphyxia in properly conducted cases scarcely ever occurs. The placental separation in the classic Cesarean section is done under the eye, and can subsequently be better controlled than in the cervical. Postpartum hemorrhage has been so troublesome to some operators in the latter procedure as to lead them to tampon the uterus. The opportunities for air-emboli would seem to be much greater in the extraperitoneal.

The disadvantages of the cervical Cesarean are: first, a difficult and uncertain technic which involves the transverse as well as the pure extraperitoneal incisions, owing to the greater germ contents of the cervical over the corporeal incision of the uterus; second, the difficult delivery of the child with the danger of extended tearing of the incision; third, the position of the scar in the thinnest part of the uterus with consequent danger in recurring pregnancies; fourth, danger of cervical fixation in the pelvis, favoring retroversion, retroflexion. In considering the technic of the procedure it is not always easy to reach the cervix without injuring or opening the peritoneum, and when this occurs the danger of soiling the peritoneal cavity is greatly increased. The extraperitoneal operation is more secure against peritoneal soiling, but it is difficult to accomplish the separation of the thin peritoneum without tearing. In clean cases such injury has no significance; in unclean, the danger is greatly increased. In 65 cases in which the pure extraperitoneal method was attempted the peritoneum was torn in 14, or 21.5 per cent. The injury occurred 10 times in the separation of the peritoneum and 4 times during the delivery of the fetus. The bladder was torn 3 times in the 65 cases. The danger of the entrance of germs is greatly increased from the opening of the vagina, which takes place in this procedure.

Repeated retroversions of the uterus have resulted from the pelvic scar in the extraperitoneal operation. The bladder may become fixed and held high by the scar, making a subsequent operation difficult. While the danger of peritoneal infection is reduced, that of the loose connective tissue becomes much greater. Search of the literature shows 22 extraperitoneal operations and 9 deaths. Schauta had 150 cases of classic Cesarean section, with 1 death from infection. He divides the cases into three classes: First, clean, which comprise those cases which come early to operation or immediately after the rupture of the membranes, and have not been investigated with unclean hands. Second, delayed cases, where labor has been existent so long that considerable dilatation has occurred, but examination has not been made with suspected hands, and, finally, third, unclean cases where investigation has been made with unclean hands, the patient has or has not fever, and where at the time of investigation there are evidences of infection.

In considering the method of delivery, in all cases in which spontaneous birth is precluded, the character of the misproportion and the possibility of securing a living child are important questions. In misproportions of the first degree in the primipara the classical Cesarean section should be regarded as the operation of election. In the multipara the operation of hebosteotomy may be considered. In unclean cases the operator may chose between craniotomy or delivery through Sellheim's belly fistula. In severe misproportions of the second degree in pure cases the Cesarean should be the operation of choice, and in the unclean, the Porro, or delivery through Sellheim's fistula. Of the alternative procedures, hebosteotomy is an operation which has had enthusiastic advocates. Sellheim indicates the following dangers:

Injury of the bladder and urethra, hemorrhage, formation of pockets in the extraperitoneal wound, prolonged confinement to bed, the possibility of an abdominal hernia, the danger of traumas of delivery, and the danger of asphyxia for the child. Schauta performed 50 hebosteotomies without the loss of a mother. Injuries of the soft parts were common when the procedure was employed for the first delivery. Among these hebosteotomies were 3 dead children. Hebosteotomy must be combined with the most careful delivery, and should not be employed in the primapara because of the danger to the soft parts. Indeed, with improved methods in the management of obstetric cases and the early recognition of the causes of obstruction, Cesarean section would seem to be the procedure of election in all cases in which the obstruction occurs from a disproportionate size of the fetus and pelvic outlet.

George M. Boyd reported 27 cases of Cesarean section without a maternal death, and with the loss of but 1 child. In this case hysterectomy was performed for labor obstructed by a large fibroid. The patient was septic, and the child had been dead for some time, so that, even in it, the operation was not responsible for the death of the fetus. In 14 of his cases section was performed before labor; in 13 the patient had been in labor six hours in the shortest case and forty-eight hours in the patient demanding hysterectomy; 6 of his series of cases had had Cesarean section in previous labors. The operation in 5 was for the second time, and in 1 for the third. He employs either the vertical or transverse fundal incision of the uterus. In either case the incision should be clean and only large enough to admit of ready delivery. The fundal incision is advocated by some, because when closed properly the line of union does not come in contact with the abdominal wound, and affords no opportunity for intestinal adhesions. Boyd prefers silk for the uterine sutures.

Where a woman is unable to deliver herself, and especially in conditions in which it is absolutely necessary that delivery shall be accomplished by Cesarean section, the question of sterilization to prevent subsequent conception becomes an important question. There are advocates for and against, but as De Lee remarks, it becomes an ethical question whether either parent has the right to demand that sterilization should be done. Sinclair does not approve of it except in special cases of fibroid and carcinoma, because of increased gravity and the time consumed, but these objections are scarcely valid. McPherson, from his experience in the New York Lying-in Hospital, opposes the procedure, and says there is not so much danger to the mother from Cesarean section as in some other methods of delivery, especially the high forceps, and no danger to the child. The danger from the scar can be avoided in proper closure of the wound. He emphatically objects to Sinclair's suggestion that the operator should aim to secure adhesions between the uterus and the abdominal parietes. He reports 39 cases of repeated Cesarean section, of which 30 were done for the second time, 7 for the third, and 1 each for the fourth and fifth times. In 18 there

were no adhesions; in 11, very few. In 1 the uterus was adherent to the abdominal scar, and in 2 there was no record made. The uterine scar of the former operation was not observed in 9; was no thinner than other portions of the uterus in 2, was very thin in 4, and ruptured in 1, the latter being the one in which many adhesions existed. In these 39 cases there were 3 maternal deaths; 1 from anesthesia before the operation was done, 1 from sepsis on the third day, and 1 from pneumonia on the fifth. The fetal mortality comprised 1, the child dying from hemophilia on the sixth day. In line with what I have said as to the extension of Cesarean section, Pankow urgently advocates the procedure in placenta prævia, and states that he had no mortality in 23 women thus treated, while there were 8 deaths in 49 in which other procedures were employed. He is confident that 6 of these might have been saved by prompt Cesarean section. All the children in the 23 cases were delivered in good condition except 1, which had inhaled amniotic fluid. Carstens reports a Cesarean section in which the pregnant uterus was lying within the sac of an umbilical hernia; the patient recovered after operation.

Vaginal Cesarean Section in Eclampsia.—The rapid delivery of the fetus by the vagina through incision of the cervix is a procedure which has gained in the estimation of the profession. Henry D. Fry says it has done more to reduce the death-rate in eclampsia than any other procedure. Stamm, of Fremont, Ohio, was the first to present the operation in this country. Palmer Finley does not consider it equal to abdominal Cesarean section. Edgar and Hirst quote Charpentier on abdominal Cesarean section for eclampsia, with a maternal mortality of 36.26 per cent. Hillman's collection showed 40 operations, with a mortality of 50 per cent. for mothers and 45 per cent. for infants. Olshausen showed a mortality of 33.3 per cent. Joseph B. DeLee earnestly advocates the importance of prompt treatment of eclampsia, and quotes Winter as stating that of 29 patients treated before they had six convulsions not one died, and in 32 cases 3 women were lost, while under a waiting policy the mortality was much greater. Thus, in eclamptics treated expectantly with spontaneous labor the mortality was 40 per cent. Treated with expectancy until the os dilated, 30 per cent. With mild measures employed for hastening the labor, as metreurysis or incisions, the mortality was 25 per cent., with vaginal Cesarean section in 34 cases, 9 per cent. Where vaginal Cesarean section was performed immediately after the first attack, in 22 cases there was no mortality. (For methods of procedure, see Vol. V., p. 486.)

Uterine Displacements.—(See Vol. V., p. 490.)

Prolapsus uteri is a hernia through the vaginal opening. These hernias may be divided, according to the situation and the structure involved, into three varieties: first, pre-uterine, in which the protrusion is formed by the bladder and anterior wall of the vagina, commonly known as cystocele; second, uterine hernia, which is a primary prolapsus of the uterus, and is also designated as uterovaginal prolapse; third, retro-uterine hernia in which the posterior wall and with it, not

infrequently, the anterior wall of the rectum protrudes. This condition is also known as rectocele. We may have in some instances a dissection downward of the peritoneal pouch associated with the intestines, in which there may be a projection of the small intestine at the vulva.

Sagging of the anterior and posterior walls of the vagina together may lead to the formation of a form of prolapsus known as vagino-uterine prolapse. In this there is a more or less extensive eversion of the vagina, with either complete prolapse of the uterus, known as procidentia, or a dragging out and attenuation of a portion of the cervix, producing what is known as hypertrophic elongation. These herniæ are indications of weak points before and behind the uterus. Violet says the anterior is the more frequent, and also the more difficult to maintain in a proper position.

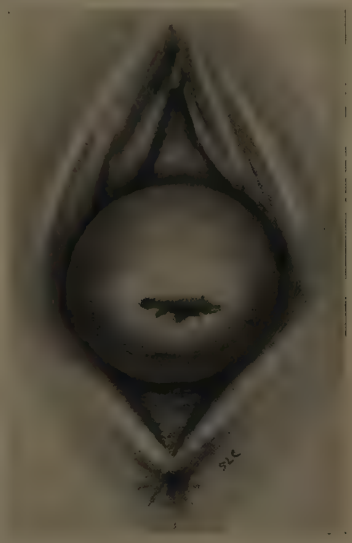

Fig. 406.—Uterovaginal Prolapse.

(For *Etiology*, *Diagnosis*, and *Mechanical Treatment*, see Vol. V., pp. 491–493.)

Violet suggests the following technic for the anterior displacement: The patient is shaved, washed, disinfected, anesthetized, placed in the

Fig. 407.—Hernia of Intestines through Rectovaginal Septum.

dorsal position, the limbs flexed and fixed, the bladder emptied by a catheter, and the operative field protected against all possibility of

soiling, especially from the anus. The neck of the uterus seized with a pair of forceps and drawn outward, the vaginal mucosa swabbed with tincture of iodin, while with a bistoury a lozenge-shaped alignment is traced out for an anterior colporrhaphy. Step one: A pair of forceps placed just below the urethra, a second on the cervix, and at equal distance from each other at either side of the cul-de-sac a third and fourth pair are placed. They indicate the lateral angles of the lozenge. The portion of mucosa within the enclosure is removed and dissected $1\frac{1}{2}$ cm. from the lips described. Step two: The bladder is separated from the anterior surface of the uterus as far as the peritoneum. This dissection may be quite difficult; when associated with hypertrophic elongation of the neck the line of cleavage is separated by pressure of the tampon and finger, but more frequently has to be done with the scissors. Several arteries are divided during this dissection. During its progress, until the peritoneum is reached, traction is forcibly made upon the cervix. The separation should sometimes be continued for a distance of 4 to 5 cm. on the anterior part of the uterine neck and to the level of the cul-de-sac of the anterior peritoneum. Step three: The anterior peritoneum is opened well over the median line. The cul-de-sac is generally readily reached, but sometimes requires extensive dissection of the vesico-uterine space, and will be recognized by the pale, rosy red, and smooth appearance. The peritoneal opening is necessary in order to reach without danger the anterior surface of the isthmus of the uterus in its most proximal point to suture the vesico-uterine ligaments. Step four: Isolation of the vesico-uterine ligaments in the line of uterine insertion. The bladder is pushed back in the inferior triangle on the surface of the uterine neck between its lateral parts and the borders of the vaginal mucosa, and as well on the base of the broad ligament as it approaches on either side the sinuosities which cover the lateral fascia of the base of the uterine isthmus. To the outside and a little below in contact with the uterus a bundle of fibers is perceived which take an anteroposterior direction. Step five: Passage of a fixation suture in the peritoneal portion of the isthmus. The first suture passes through the base of the fibromuscular bundle and at the same time through the anterior face of the uterine isthmus. Two sutures are thus introduced through the face of the uterus and include the vesico-uterine ligaments. A proper introduction of these sutures is important

Fig. 408.—Vagino-uterine Prolapse. Procidentia.

for two reasons: (*a*) Because it permits traction on the internal border of the vesico-uterine ligaments in order that their relation can be revealed. The operator, seizing the vesico-uterine ligaments with a forceps, should keep in mind the position of the ureter. (*b*) The second consideration is that the suture constitutes a means of holding forward the uterus by vaginal fixation. When properly placed it controls the retroversion of the uterus and insures the maintenance of the organ in anteflexion. In a subsequent pregnancy it does not present the difficulties of other methods of fixation. Step six: Closure of the anterior cul-de-sac. This is accomplished in a transverse line. Step seven: Suture of the vesico-uterine ligaments after replacement of the bladder. This suturing is completed by tying the suture controlling the bladder. The operation is finally completed by the removal of the redundant portions of the anterior flaps of mucosa and the union of their edges.

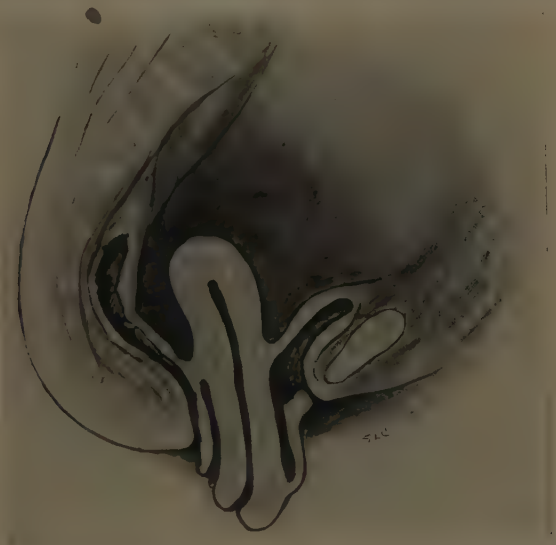

FIG. 409.—VAGINO-UTERINE PROLAPSE. HYPERTROPHIC ELONGATION OF THE CERVIX.

Goffe, in extreme cases of cystocele, procidentia, and rectocele, advocates a procedure based on the assertion that when the bladder and uterus are in their normal situation the pelvic floor has nothing to do with their support. His operation he claims recognizes the natural division of the bladder into hemispheres, the base of which is comparatively fixed, while the portion above when in collapse settles down on the base. The operation restores the base to its immobile condition, allowing the superior portion to expand as its function demands. He accomplishes this by dissecting the bladder free from its attachments, hanging the uterus in normal position by shortening its ligaments, restoring the bladder to its normal relation, and securing it there by three chromic catgut sutures, one in the median line and one at either cornu. In extreme procidentia he advises that the uterus shall be removed and the

broad ligaments sutured together across the pelvis. In all cases in which rectocele exists the perineum is repaired.

He proceeds as follows: Holding the uterus with fixation forceps, an incision is made in front of the uterus, as for hysterectomy; seizing the middle part of this incision with a hemostat, it is drawn down, while with a spur or blunt dissector he strips the bladder from the inner surface of the vaginal fascia and extends it out on either side until the organ is free. The vaginal wall is then split up its entire length well under the urethra; the base of the bladder is lifted on a retractor, the vesico-uterine pouch opened, and through this opening the round ligaments shortened and the fundus restored to its normal position.

FIG. 410.—TRANSVERSE INCISION MADE IN FRONT OF THE CERVIX AND LONGITUDINAL INCISION FROM N TO P.

The peritoneal cavity entered at *O*, the uterus carried up into place and the round ligaments shortened.

Points are then selected on the bladder which will render its anterior surface taut, and these secured to the front of the uterus and on either side to the torn edge of the vesical peritoneum, the peritoneum having also been included in the uterine suture. This procedure makes a comparatively straight line from the urethra to the uterus. After the sutures are secured the vaginal flaps are trimmed to make them lie snugly against the bladder and are stitched together throughout; the uterine end is then stitched to the uterus directly under the attachment of the bladder.

A tendency to form a cystocele or rolling out of the anterior wall of the vagina has been still further obviated by the procedure known as vesicovaginal interposition of the uterus, an operation which has been

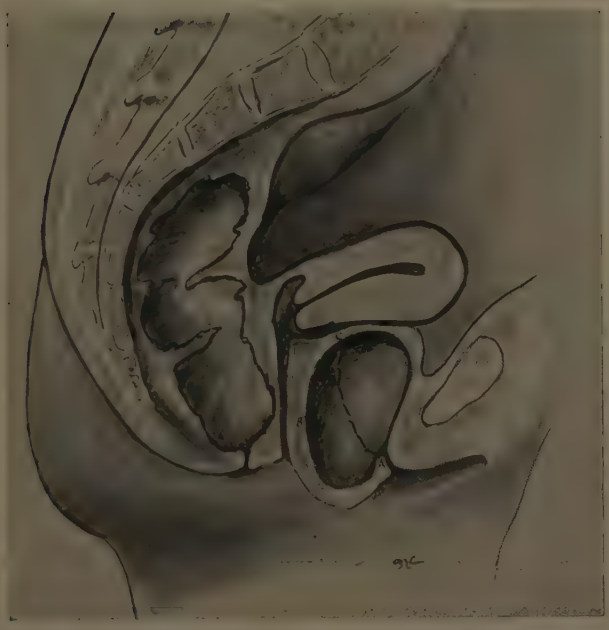

FIG. 411.—THE VAGINA HAS BEEN DISSECTED FROM THE BLADDER AT EITHER SIDE OF THE LONGITUDINAL INCISION AND THE VESICO-UTERINE PERITONEUM THROUGH POINT *B* IS SELECTED, WHICH WHEN CARRIED TO *C*, WILL LIFT THE CURVE *A–B* TO A STRAIGHT LINE, *A–C*, WHEN IT IS SECURED BY SUTURES.

FIG. 412.—POINT *C* IN FIG. 411 IS CARRIED TO *C* IN THIS FIGURE, AND *B* TO *B*. THE VAGINAL SURFACES HAVE BEEN TRIMMED TO FIT.

ascribed to Watkins and Wertheim, and modified by Schauta, Mackenrodt, Dührssen, and others. The procedure is described by Dr. J. M. Fisher in Vol. V., pp. 444, 445. This procedure has been very extensively practised either alone or in combination with other plastic operations on the pelvic floor. In a large vulvar opening the uterus and bladder, notwithstanding this procedure, are likely to be forced out. Pfannenstiel modified the operation in cases of metro-endometritis by removing the fundus of the uterus. The fundus was drawn through an incision in the anterior fornix of the vagina and the vesical peritoneum sutured to the posterior surface of the cervix, after which the two horns of the uterus were removed as low down as the internal os by converging lines, thus removing as much of the fundus as seemed necessary. The remaining portions are united in the median line with catgut sutures and secured between the bladder and vagina, as in the Watkins operation. This procedure has the advantage over complete hysterectomy in that the portion of the uterus retained serves to obstruct the pelvis and afford a fixed point for the uterine ligaments.

Bandler prefers vaginal interposition to Goffe's method, because in the latter the bladder is kept in front of the peritoneum, while to be effective it must be placed behind the uterus. He directs attention, however, to the importance of amputating a long cervix as a preliminary procedure. I have already indicated that these procedures, applied as they are to the anterior wall of the vagina, are not effective in maintaining the structures in place unless supported by a normal condition of the posterior segment of the pelvic floor. The important structure for supporting the uterus most effectively is the levator ani muscle. This may have been torn off on one or both sides, have undergone atrophy from long-continued pressure, or its fibers have been so separated as to permit the protrusion between them of the rectum covered by the posterior wall of the vagina. With constipation this condition becomes more and more marked until it is necessary for the patient to push up the protruding bowel from the vagina in order to accomplish complete evacuation.

Latzko describes a method of procedure for ensuring support of the pelvic floor. He makes a transverse incision in the separated posterior commissure. While with the fingers of the left hand the vaginal flap is drawn up, he pushes the tissues analward with a sponge. This discloses the posterior vaginal wall united with quite strong vessels. In this layer the separation is continued until the pouch of Douglas is reached. A sagittal incision splits the undermined posterior vaginal wall with two bow-like incisions. The uncertain flaps are so far dissected as to remove the superfluous mucosa and fascia when the tissue lies on the rectum. Two distinct layers are now ready to be united, the septum and the vagina. The arched-out rectum, the connective tissue and musculature of the peritoneum, and of the urogenital diaphragm are all united together with connective tissue. Into the visible and palpable tissue regions blunt scissors (closed) are introduced and separated. The existing opening is spread apart by the fingers. In the depth can

be seen the levator ani at the side of the rectum. This is the lowest part of the puborectalis, and by strongly separating the parts the belly muscle on one side is picked up with a needle and united by suture with the one on the opposite side. Over this muscular plate the strong muscular tissue and fascia of the perineum is united. This is not a universal procedure, but it is important to furnish the proper support; it is an essential part with anterior colporrhaphy and support of the bladder.

Tandler and Halban, in discussing prolapsus, say the failure of the various methods of retaining the prolapsed organ has impressed them that it is not through the creation of bands and other means of suspension that it is to be overcome, but as it has arisen through insufficiency of the muscular closure of the pelvis, the latter must be restored as in other forms of hernia. In the normal situation of the genital opening there is no danger of hernia or prolapse because the normal relation of the organ is such that the pressure is resisted by the muscular under layer. When this support is lost there is a pressing out of the structures. The organs can be subjected to operation on the ligaments to fix them in the pelvis, but the intra-abdominal pressure will sooner or later again reproduce the displacement. When the uterus can be kept in anteversion, this condition is less likely to occur. The displacement is best controlled by antefixation of the uterus and reconstruction of the pelvic floor. In prolapse of moderate degree the restoration of the pelvic floor by drawing in the levator ani muscles is effective, but in extreme degrees this operation is insufficient and there is a recurrence.

The Schauta-Wertheim method, which we call the Watkins, has seemed to serve a good purpose, but the uterus rests on the levator ani, and when it becomes paralyzed thereby, or the genital opening is large, the uterus comes to lie on it or is forced through. This complication can be prevented by suturing the edges of the puborectalis in front of the rectum beneath the flap of the vagina. The separation is made by sharp and blunt dissection until the rectum is separated from the vagina, when these structures are united by four or five sutures. Following the suturing, a part of the superfluous vagina may be resected. This operation narrows the vaginal opening anteroposteriorly, while there is also a narrowing in the transverse direction. Heidenhain relied on this suturing of the levators alone, but the operation of Watkins usefully supplements the procedure. It fixes the uterus in anteversion and serves to support the bladder. The removal is more effective than the removal of the uterus, for in the latter a part of the support has been removed and herniæ of the bladder and anterior vaginal wall are prone to occur. The levator muscles, although sutured, become weakened and strained. In such cases the floor can be strengthened by utilizing the borders of the gluteus maximus to reinforce the levators. The operation is done by making an incision alongside the vulva or the edge of the labium majus backward to the posterior commissure, from thence over the perineum to within $\frac{1}{2}$ cm. of the anus, following around it in bow shape, and carried back in a median line to the coccyx. An incision

is carried from this to the tuber ischii along the side of the pelvis, after which the outlined flap is raised, the median part of the gluteus maximus is set free, and attached to the transverse fascia in front, to the sides of the vagina, to the muscles of the opposite side in front and behind the anus, and to the sides of the latter. In this separation of the muscle flaps the following points should be remembered: (1) The muscle must be cut loose from the tuber ischii or it will be too short; (2) it must be three fingers broad or it will not fill the space. The muscle is innervated

FIG. 413.—ISOLATED SUTURE OF THE LEVATOR ANI MUSCLES.

through branches of the inferior gluteal nerve and nourished by the blood-vessels so that it will not become necrotic.

Schiffmann and Ekler, in discussing the various methods of operating for prolapsus and the relation of the pelvic floor thereto, present a collection of 134 cases. Of these, 30 disappeared without investigation, 87 were personally investigated, and 16 by others, with 1 fatal case. Of operations with isolated suture of the levator ani there were 48 cases, in which 15 had total prolapse and 33 slight. Of the 15 cases of total

prolapsus, 3 had recurred, 2 slightly, without any subjective symptoms. The other recurrence was severe, giving the subjective sensation of a foreign body. Urinary symptoms were wanting in all. Tearing or striking degeneration of the levators had been observed in 5. Of these 5, 2 recurred and 3 presented a satisfactory result. Of the 33 easy cases, 32 had satisfactory results, 1 moderate. In 2 there was dribbling of urine in stooping and working; in 3 marked weakness of the levator had been noted, but in all 3 the result was satisfactory. Retroflexion accompanied the prolapse in 5 of the 15 total and in 14 of the 33 light cases. This displacement was obviated by the vaginal fixation operation of Schauta. Only in a quite old woman was the position overlooked. As

Fig. 414.—Flap of Gluteus Maximus Muscle Utilized.

additional operations in the 15 total prolapse cases, vaginal fixation was done in 1, vaginal interposition in 10, and vaginal hysterectomy once. In the 33 light cases, vaginal fixation was done 10 times and interposition in 6 cases. In 1 of the cases of recurrence after vesicovaginal position the fundus uteri appeared at the vulva.

The operation was done without isolation suture of the levator ani in 39 cases, of which 6 were total prolapse; of the latter, 3 recurred. In these 3 the levators were subsequently united and 1 again recurred. None of the patients complained of urinary symptoms. Of the 33 light cases, the levators were united in 21 and 4 had dribbling of urine. Of the 6 cases of total prolapse, 4 had retroflexion, and the prolapse opera-

tion was twice combined with vaginal fixation, and once with shortening of the round ligaments. Retroflexion was found in these 33 cases 11 times, for which interposition was done in 2 and vaginal fixation in the remainder.

Of the 16 cases not personally investigated, in 6 the isolated levator suture was inserted for total prolapse of the uterus, and 1 with inguinal hernia and retroflexion combined. In one, interposition, and in the other, vaginal fixation, was done; both remained free from symptoms. Of 4 light cases, 2 had retroflexion, and 1 of these crural hernia. Vaginal fixation was done in both and they remained free from symptoms. The experience of Bumm and Lawson Tait have demonstrated that perineal operations are not free from danger. Leichtenstein reported a death from pulmonary embolism. Cohn's statistics gave 3 deaths in 105 cases; Bumm had 2 deaths in 150 cases, 1 from nephropyelitis and 1 from peritonitis. Jacoby reported a death from pneumonia, and Joly 2 fatal cases of pulmonary embolism in 33 cases. In 134 cases there was 1 death (0.75 per cent. mortality). The case was a woman fifty-eight years old, with ruptured perineum and cystocele; she died the fifteenth day following the operation, with pulmonary embolism. Joly attributes the occurrence of this lesion to opening the large veins of the pelvic floor. The suturing of the levator is associated with injury and thrombosing of large vessels.

As to the morbidity, a series of cases of cystitis and a case of pneumonia recovered. In operations of serious character there were 15 cases with 12 recoveries and 3 recurrences, or 80 per cent. of recovery. In the lighter cases there were 33 with 1 relapse, making a percentage of recovery of 97 per cent. In a large number of cases, much to my astonishment, I found the levator ani muscles united where they had not been sutured. The great value of the isolated levator suture was seen in the cases where total prolapse existed. A tendency to a recurrence of the condition was greatly lessened. The interposition operation was not satisfactory where there was a small uterus or the introitus large. In such cases prolapsus was likely to recur. The operations of fixation or interposition when performed during the child-bearing period should be associated with sterilization. Of 6 patients reported by Heidenhain, one-half died of sepsis in child-bed and of the remaining 3, 2 had recurrence. Latzko's assertion that the levator suture and the possibility of pregnancy were antagonistic is correct, for subsequent delivery would be associated with extensive laceration or pushing apart of the muscle.

The analysis of these investigations seems to justify the following conclusions: (1) In slight prolapse it is sufficient to secure a strong floor through the suturing of the non-isolated levator ani; (2) in difficult cases the suturing of the isolated levator ani in the manner suggested by Latzko is indicated; (3) existing retroflexion is corrected if the uterus is not atrophied; (4) strong cystocele is an indication, as a supplemental operation, for interposition of the uterus.

Prolapse operation should, as a rule, be associated with sterilization of the sexually active woman. Kraatz, in rectocele, where from want

of support of the intestines and the rectum the posterior vaginal wall has become prolapsed secondarily, says usually a severe prolapsus may be overcome by perineocolporrhaphy, but where there has been marked degeneration of the puborectal structures, special measures had to be instituted. For this class of cases he suggests the rectovaginal interposition of the uterine fundus. The uterus is drawn through the posterior wall of the vagina and partially or completely covered with the vaginal wall. The operation is completed by a good colpoperineorrhaphy. This operation affords the advantage of giving a firm support to the defective rectovaginal section. The uterus also forms a good barrier against the escape of the viscera through the canal. It no longer affords a surface for the downward pressure, and depression of the organ is impossible with the perineum in good condition.

The operation is performed as follows: A transverse incision is made in the posterior vaginal fornix about 8 cm. long; a vertical incision permits the vaginal mucosa to be raised from the rectum, and the peritoneum of Douglas is opened transversely, through which the fundus is turned downward, and after resection is placed between the vaginal flaps of mucosa and secured by three or four deep sutures. Superfluous parts of the vaginal wall are resected. The uterus may not be completely covered, but it is better that it should be; if necessary a wedge-shaped excision of the fundus may be made. Where the cervix has been lacerated or hypertrophied, a preliminary amputation should be done. A curetment and the necessary anterior colporrhaphy may precede the operation. A resection is inadvisable, for the protrusion of the intestines results, most frequently from the absorption of the adhesion of the vagina, while it will be held back by a firm union with the fundus.

In total prolapsus of the uterus Dr. R. Joly has suggested an operation for the total removal of the uterus which seems to offer the most certain obstacle to recurrence of this form of vaginal hernia. In Olshausen's clinic 34 operations were done by this method. Drawing out the uterus, an incision in the vagina is begun from one to two fingers' breadth below the protrusion of the urethra, which encircles the protruding mass to the left, and then to the right, and is completed by lifting the portio vaginalis. The under part lies quite near to the latter. This portion forms the fornix of the vagina, and that tube is only sufficiently long when the entire posterior part of the vagina has been preserved. The incised flaps are dissected back, partly by sharp and partly by blunt dissection, first anterior, then posterior, and the portio vaginalis clamped to prevent soiling of the wound by discharge from it. It is important that the lateral and posterior parts of the vagina shall be free, otherwise the later separation of the uterus will be difficult. In the anterior surface the bladder is visible and should be shoved up by blunt dissection until it is no longer connected with the uterus. The ureter is shoved up with it and carried completely out of the range of operation. Injury or ligation of the ureter is thus prevented. If the bladder is not shoved up with a gauze tampon, it may be torn. The bladder, thus pushed off, is secured by transverse sutures which pass from one side of the bladder

wall to the other and thus fix the organ. The uterus lies outside the vagina and is still covered with peritoneum. The anterior peritoneum is cut transversely, the fundus seized and brought forward, and a tampon carried over it to hold the intestines out of the way. If the fundus lies well forward, it should be separated before suturing the bladder, or the opening will be too small. With a Deschamp needle, ligatures are carried through the left ligament, with which it is ligated from its upper portion to beneath the portio vaginalis, for which four or five strong ligatures may be required. The same course is pursued on the right side. Both stumps are then drawn down and temporarily secured with

FIG. 415.—CLOSURE OF THE WOUND, UTILIZING THE FLAPS FOR PELVIC SUPPORT.

clamps. The parietal margins are united with five knotted sutures. The abdominal cavity is closed and the stumps are finally drawn out. These stumps are united with sutures; the peritoneal surfaces, by invagination. The stumps thus firmly united form a thick border, which lays before the peritoneum and behind the vaginal wall. In this relation exists the difference between the method and the cases in which stumps are drawn into the vagina. The vaginal wall is united by continuous sutures. A posterior colporrhaphy follows this, in which the deep muscles are brought together with three or four deep sutures. Finally, the skin and fascia are united over the deep sutures, thus constructing a long and narrow vagina.

In many cases the plastic operation on the anterior and posterior walls will afford more satisfactory results if supplemented by an abdominal incision through which the anterior ligaments are shortened, or the recto-uterine peritoneum is so plicated as to draw back on the cervix. Philander A. Harris has suggested that through a median abdominal incision, starting 1 inch below the umbilicus and carried 3 or 4 inches downward, the body and fundus of the uterus should be drawn. The uterus is held by an assistant, while the operator sutures the parietal peritoneum to and around the uterus at the junction of the cervix with the body. This suturing crosses the broad ligament at either side about 2 inches from the fundus, and is followed by a closure of the peritoneum with the fundus outside. A gauze and rubber tissue drain is carried to one side through a stab-wound. The anterior surface of the uterus is denuded and stitched to the under surface of the recti muscles. The aponeurosis is sutured with chromic catgut, and, finally, the skin closed with a running suture. If there is a thick fatty wall, the surface is drained with gauze through a stab-wound. This operation is applicable only to women in whom pregnancy is no longer possible.

Retroversion and Retroflexion of the Uterus.—(See Vol. V., pp. 501, 502.)

L. Adler, discussing the variety of procedures for relief of retrodisplacements, says: "The great number of operations suggested indicates that none of them are perfectly satisfactory." In harmony with Hofmeier, he presents the following postulates: (1) A procedure for relief must be one that offers no danger to the patient, neither in relation to the primary mortality or morbidity, nor gives occasion to later complications, such as obstruction of the intestines, disturbances in pregnancy or labor, or herniæ; (2) the aim of the operator must be to secure a good position of the uterus which shall endure the test of labor; (3) the symptoms produced by the lesion must be relieved.

Some authors, as Vedeler, Theilhaber, and Jenkins, have denied that retrodeviations rise to the point of being pathologic conditions, and assert that too much attention has been given them. In ten years (from 1899 to 1909) 304 patients were subjected to operation in Schauta's clinic, of which in 228 the operation was vaginal; in 73, abdominal; in 3, inguinal. This table comprises only the cases in which the operation was done for correction of retrodisplacement, and not for such complications as prolapsus and adnexal tumors. The time between the operation and the subsequent investigation of the cases was from one to ten years, and in none less than eleven months, so that they were particularly valuable for the determination of the results.

First, vaginal methods were employed in 228 women, of which only 132 subsequently came under investigation. The vaginal methods are divided into, first, direct vaginal fixation, (*a*) high, (*b*) deep; second, shortening or fixation of the round ligaments; third, combined methods.

Direct Vaginal Fixation.—This consisted in an anterior colpotomy through which the bladder was raised, the plica of the peritoneum opened, the uterus drawn through and fixed by one or two silk sutures

either at the height of its fundus or about 1 cm. thereunder, or at the level of the internal os, or 1½ cm. above.

Deep Vaginal Fixation.—The sutures were carried through the anterior uterine wall, the peritoneum and the vagina, after isolated closure of the tract. As a preliminary step, extensive adhesions should be broken up, and, where necessary, a drain inserted through Douglas' pouch. The disturbances in subsequent pregnancy were so marked in patients in whom these operations were done that of late years they have been considered as practicable only where pregnancy is no longer expected. Following the discontinuance of these vaginal fixation operations, shortening of the round ligaments was practised and their fixation in the vagina.

During the course of years this operation through the vagina has undergone various modifications. Thus, it was folded upon itself, the ligaments secured to the anterior surface of the uterus, loops fastened in the vaginal wound, either at the angle of the transverse incision or a loop of each ligament was brought out and buried in the anterior vaginal wall at a point just above the urethra, thus supporting the bladder. In some instances the starting-point of the ligaments were secured in the vaginal wound. (It is extremely important that the incised or torn peritoneal surfaces should be accurately adjusted in these cases, for some of the most difficult dissections for intestinal adhesions I have ever experienced have followed in these cases of vaginal operations.) Adler found the subjective results better than the objective. Where the uterus had been previously movable, the results were satisfactory. In those cases, however, in which extensive adhesions were broken up preliminary to the anterior fixation procedure, the tendency to recur was most marked.

Simultaneously with the ligament fixation, colporrhaphy and perineal operations were done in 38, and operation on the cervix in 11. Of the investigated cases, 18 had been pregnant. Spontaneous labors had occurred in 15; 3 were pregnant at the time of investigation, 3 had aborted. In considering the results, one is impressed with the great number of recurrences where the displacement had been complicated by adhesions; recurrence followed in 24, or 63.3 per cent. of 38 such cases, and this recurrence is common to all the operations except the high direct vaginal fixation, and the latter is associated with difficulty in labor; consequently, all vaginal fixation operations were rejected by Schauta. As regards the influence of the procedure upon pregnancy and labor in the 132 cases investigated, 2 must be excluded from consideration, as they had been sterilized. Of the 130 remaining, 43 became pregnant. Of 94 women in whom the retroversion was movable, 36, or 38.3 per cent., became pregnant following operation; while of 36 complicated adhesions, 7, or 19.4 per cent., became pregnant. It has been recognized that women with perimetric fixation rarely become pregnant because of the simultaneous alterations in the endometrium and the adnexa. The fact, however, that nearly 20 per cent. do conceive after operation emphasizes the importance that the method employed shall

be one which will not of itself act as an obstacle to the course of pregnancy or of delivery.

Abdominal Methods.—Subsequent to 1906 the Pfannensteil incision has been exclusively used, and is valued especially for its freedom from hemorrhage and its cosmetic effect. The methods employed were: (1) The direct ventrofixation method; (2) the Olshausen method; (3) the method of Doleris.

The direct ventrofixation (Czerny-Leopold) was employed in 14 cases, and an opportunity for investigation in 11 of these cases was obtained. Anteflexion was found in 10 and retroversion in 1. But 2 of these cases were movable prior to operation, and laparotomy was chosen for them, once because of recurrence after vaginofixation, and in the other on account of inflammation of the adnexa. Of these 10 women, 6 were sterilized; in 2 there had been one-sided extirpation of the adnexa; in 1 an ovary extirpated, and in 1 a nut-sized myoma enucleated. The subjective symptoms in these cases did not harmonize with the objective. The patients with recurrence were free from symptoms, while 2 patients, in spite of orthopedic results, complained of pain. None became pregnant after the operation.

The Olshausen method was employed in 9 cases, of which 6 were investigated. The uterus retained its position in 5 and retroversion occurred in 1. In but 2 were the uteri movable prior to the operation. The abdominal route was chosen on account of strong vaginal and cervical catarrh; the second time because of retrocecal tumors. Two of these patients became pregnant and there was no disturbance in delivery, although in 1 a retroversion followed. In later years Olshausen's has been substituted by the Doleris operation.

The Doleris method was employed 50 times, of which 4 were during pregnancy in a retroflexed uterus. In 3 of the cases of pregnancy the displacement recurred in a few months, so there remain 47 cases for determining the duration results. Of these, 41 had been fixed retrodisplacements and 6 movable. In none was there recurrence, making an objective result of 100 per cent. Three of the patients complained of subjective symptoms. In one the stigmata of hysteria were recognized; in another was found parametritis and left oöphoritis; while in the third the most careful examination failed to afford any explanation.

Of a number of women operated on in the clinic by the Gilliam operation, 7 had been pregnant twelve times; one of these underwent operation for a ruptured tubal pregnancy. All the rest ran a normal course. He condemns ventrofixation operations in all cases where women are likely to bear children, as the thinning of the posterior wall endangers rupture.

Guggisberg, discussing the possibility of intestinal obstruction after operation, especially ventrofixation, says that Olshausen reported 1 case. He mentions two methods of procedure, that of the original Olshausen and the Leopold-Czerny procedure. He recounts 1 case of his own and 3 others in which ileus followed the operation. A number of cases are reported in literature in which obstruction has occurred either immedi-

ately following operation or at a later date. These cases make it evident that the operator cannot be indifferent to artificial bands within the abdominal cavity. Gilliam felicitates himself on the simplicity, safety, efficiency, and facility of execution of the operative procedure known by his name, and thinks the objection that it endangers strangulation of the intestine is unworthy of consideration, inasmuch as no cases have been recorded of its occurrence. Frank C. Hammond recently reported to the Philadelphia Obstetrical Society a death from intestinal obstruction as the result of conditions following Ferguson's modification of the Gilliam operation.

Kraatz advocates the Alexander-Adams operation under local anesthesia. He infiltrates the skin in the region of the anterior spine of the ilium and over the inguinal opening with 2 c.c. of ½ per cent. of novocain-suprarenalin solution. A similar quantity of the solution is employed in the region of the internal ring, while 1 c.c. is used about the middle of Poupart's ligament where the round ligament enters the inguinal canal. The Alexander operation, however, has, as Dudley says, become obsolete. He pins his faith to the Webster operation, although he thinks the pessary has been neglected.

The so-called Webster operation and Baldy's modification would seem objectionable, in that they afford opportunity for adhesions at a point which would readily favor the occurrence of ileus. Any operation within the abdominal cavity for retrodisplacement should be as free as possible of peritoneal injury, by which adhesions can be formed. It should exclude all peritoneal bands and artificial ligaments, and should be of such a character as to prevent the possibility of recurrence of the lesion. This in cases uncomplicated by prolapsus seems most effectually accomplished by the extraperitoneal shortening of the ligaments from within the peritoneal cavity, whether the procedure of effecting it be that of Simpson, Mayo, Crossen, or my own.

Montuoro lauds the operation of Pestolazza for retroflexion of the uterus, which is performed as follows: Through a median abdominal incision, after correction of diseased conditions of the appendages, a catheter is inserted in the bladder to determine its angle and relation to the anterior wall of the uterus. He picks up the uterus with a long pair of forceps at the point of the reflexion of the peritoneum and makes a buttonhole opening with a pair of scissors. The latter is spread the entire length of the uterine segment, and also, to a slight extent, on the anterior surface of each broad ligament. Not only the peritoneum, but also a portion of the muscular layer is cut; sometimes the latter can be torn with the fingers. Occasionally severe bleeding will follow from injury of considerable sized vessels, but they rarely require a ligature. After the formation of these flaps, the next step consists in the introduction of several sutures through the fundus and the median portion of the flap about ½ cm. from its free margin. When these sutures are tied the uterus is brought into a position of anteflexion.

Myomata.—(Myomatous Growths, Vol. V., p. 518.)

Myomatous degeneration of the uterus predominates during the

period of active sexual life. Franz, in analyzing 276 myomatous operations, found that 2.8 per cent. were between twenty and thirty years of age; 14.8 per cent., between thirty and forty years; 62 per cent., between forty and fifty years; 19.6 per cent., between fifty and sixty years; 0.8 per cent., between sixty and seventy years. It has been asserted that fibroids occur more frequently in the unmarried and nulliparous woman; that fibroid manifestation was a penalty she paid for her freedom. Haultain found in 500 cases that 39 per cent. of them were single and 61 per cent. married. Of the married, 42 per cent. were childless, and 40 per cent. of those who had children had but one. A. B. Keyes, quoting Winckel, found 91 per cent. of fibroid growths in the body of the uterus and 9 per cent. in the cervix: 65 per cent. of the former were interstitial; 24.3 per cent., subserous; 10.7 per cent., submucous. All three varieties of the growth may be found in the same uterus. Interstitial tumors do not always remain such, as they may be extruded from the wall and become either subserous or submucous. The baneful influence of the fibroid growth is not confined to the uterus. It is difficult to account for the secondary changes which occur in remote organs. It is possibly due to some toxic product generated in the tumor, which has a destructive influence upon the structures of certain organs. Theilhaber directs particular attention to its degenerative influence on the heart as shown (1) by the relatively large number of people with myomata not undergoing operation, who die with symptoms of heart insufficiency; (2) a relatively large number of such patients die during or shortly after an operation without the narcosis or loss of blood occasioning it, and in which no other cause than the heart insufficiency can be assigned; (3) such disorders as thrombosis and embolism are disproportionately frequent after operations for myoma. He believes that the simultaneous occurrence of myoma uteri with many internal diseases, such as heart disease, contracted kidney, and diabetes, is not accidental. In most of the cases the affection has been disorder of the heart muscles, and is indicated by pain, pressure of the myoma on the sympathetic plexus, the growth of the tumor, in which it is probable the heart degeneration is induced by the influence of the tumor growth and its demands on the nutrition of the patient; (4) a mechanical influence occurs in the pressing upward of the diaphragm and the contents of the thoracic cavity which hinders the respiration, makes oxidization of the blood defective, the nutrition of the heart suffers, and this exercises an unfavorable influence on the heart muscles; (5) the unfavorable influence on the heart's action can be induced by the deteriorating influence of the pressure of the tumor on the processes of digestion; (6) menorrhagia and metrorrhagia can lead to degeneration of the heart muscle from long duration; (7) in the majority of patients the cause of degeneration has been the process of arteriosclerosis.

Franz, in 170 cases in which careful investigation was made, found 27 (15.9 per cent.) where such alterations of the heart had occurred, as impure tone, noise, enlargement, and irregular or limited action. The degenerations are more frequent, however, in the growth itself, as

Samuels quotes Tracy as having found in a series of 3561 cases, 1147 reported degenerations and changes in the tumor and the uterus. Two or more of these degenerations, however, may be noticed in the same patient, which would indicate the number of patients are less than one would at first assume. Samuels concluded that (1) a large majority of fibroid tumors undergo some form of degeneration, and occur with greater frequency in women over forty years of age (64.9 per cent); (2) fibromyomata uteri and visceral degeneration are associated in a large number; (3) young women, anxious for maternity, who have small tumors which do not cause symptoms should not be subjected to operation, but should be kept under observation; (4) all fibromyomatous tumors producing symptoms regardless of the patient's age, and all such growths in women forty years of age or over, should be subjected to operation when diagnosticated because the operative mortality is less than 5 per cent., while 12 to 14 per cent. is the risk in carrying the tumor.

Myomata and Conception.—An important effect of myomatous growths is their influence on conception. The majority of gynecologists have regarded myomata as productive of sterility. Schauta in 1896 asserted that it was the rule for myomatous patients not to conceive, and if they do, to abort. When this subject, however, is carefully studied, it is found to be a complex problem. A superficial investigation on the subject would seem to indicate that such growths were a cause of lessened fertility, especially as women suffering therefrom average but 2.6 per cent. pregnancies, which is much less than the average for married women. On the other hand, when we consider that over 62 per cent. of cases that come to operation have occurred between forty and fifty years of life, while procreation is most active before the thirty-fifth year, the question might arise whether myomata and want of fertility were not due to the same cause.

Goetze makes the following summary of the prognosis on the possibility of conception for a woman in whom myomata are discovered: (1) Small subserous myomata do not affect the probability of conception, as they increase, the probability decreases, but large myomata do not necessarily preclude its occurrence; (2) the submucous myoma gives the most unfavorable prognosis for conception, and this becomes worse the more extensive the alterations in the mucosa and the severer the hemorrhage. One will in such cases regard a radical procedure as less objectional, as these growths are most frequently found in women who have had children. The interstitial myoma holds the intermediate position, and increases the difficulty of conception the more it affects the endometrium by encroaching on its cavity; (3) myoma of the cervix seems to offer more probability of conception than does myoma of the body; (4) pregnancy having occurred, the probability of abortion is greater than when the uterus is normal; (5) if no other hindrances to conception exist where the conservative removal of myomata is possible, the chances for conception are improved, and are increased the more, the less severe the surgical procedure, the slighter the alterations of the mucosa, and the earlier the condition is diagnosticated; (6) if enucleation of the growth is

not possible, no hope for conception after the thirtieth year of age seems to exist in women whose uteri are occupied with interstitial growths of large size.

Lobenstein says that a myomatous condition of the uterus predisposes to sterility; he quotes Parvin as saying the average sterility is 1 to 8, but in myomata it is 1 to 3. The tendency to abortion is increased, and in bad cases both spontaneous and artificial abortion are difficult and dangerous. The baneful influence of myomata is not confined to the limitation of pregnancy. Should the woman become pregnant, she still runs the gauntlet, depending to a great extent upon the character and situation of the growth. Johnson says that if the tumor is attached to the fundus, or if it is subperitoneal, it may cause little or no trouble. If it is interstitial and encroaching on the uterine cavity, fetal malposition, placenta prævia, irregular uterine contractions, abortion, or hemorrhage during labor may be some of the resulting complications; if the tumor is submucous, anticipate hemorrhage, abortion, and sepsis; if the tumor is located about the cervix it may obstruct delivery, or if the latter is accomplished by some obstetric operation, hemorrhage or sepsis may follow; similar complications may attend the intraligamentary and intrapelvic growths unless they can be pushed out of the birth-canal. Small fibroids attached high, but with long pedicles, may be displaced downward, giving rise to as much difficulty as tumors in that situation. Fibromata have been known to cause extra-uterine pregnancy.

Influence of Pregnancy on Myomata.—The complication of pregnancy has a marked influence on myomatous growths, as they are likely rapidly to increase in size because of the increased uterine vascularity. The tumor may become impacted in the pelvis and form extensive adhesions. Intraligamentary growths may cause intolerable pain from being crowded against the pelvis, and later result in necrosis and sloughing. Cervical and submucous fibroids may be expelled into the vagina and be safely removed. Peritonitis and sepsis are often caused by necrosis and sloughing of tumors whose circulation has been obstructed by pressure. At the time of labor the irregular contractions of the uterus occupied by fibroid growths may render labor slow and ineffectual. If they are small and high up, or large and subperitoneal, they may not exert much influence. If they are either large or small, but situated in the pelvis, a surgical procedure may be required for the woman's delivery. Cervical fibroids may make Cesarean section or hysterectomy necessary to save the lives of the mother and child. Notwithstanding these apparent perils, it is astonishing how frequently nature clears the way in what seemed insuperable difficulties and enables the patient to deliver herself. The dangers incident to the growth from pregnancy and to the life of the mother and fetus render it wise to advise single women suffering from fibroid growths not to marry. Cuthbert Lockyer says the majority of cases of fibroid may be left alone when complicating pregnancy, and then proceeds to give the following risks of non-interference: (1) Rapid increase in size of tumor, causing severe pain and distress; (2) incarceration of the tumor in the pelvis; (3) serious pressure on the bladder; (4) degeneration

of the tumor through diminished nutrition; (5) excessive rotation of the pregnant uterus; (6) abortion or premature labor as a result of pressure or of submucous development of the fibroid.

The size to which these growths attain, the disastrous effects exerted on the general health from hemorrhage, pain, and pressure, the absorption of toxic products, the degenerative processes to which they are incident, and the disastrous effect of possible pregnancy have led many surgeons to advise the extirpation of every myomatous uterus. Where possible, others have been content with the enucleation or removal of the myomatous growth, endeavoring to preserve the uterine function. This is particularly desirable in women who have not as yet reached the age of thirty-five years. In many such cases the vasomotor disturbances of the premature climacteric are so boisterous as to make the patient feel she has escaped from one discomfort to another even more distressing and trying. For this reason Alvan H. G. Doran makes an urgent appeal for retention of part of the uterine mucosa based on subtotal hysterectomy for fibromyoma in 100 cases. His assertion that preservation of a portion of the uterine mucosa exerts a beneficial influence and even continues the menstruation where both ovaries have been removed is difficult to credit, inasmuch as it is well-known that regular menstruation ceases when both ovaries are removed, even though the entire uterus remains. He summarizes his 100 cases as follows: In 40 cases, or 40 per cent., both ovaries were removed and the menopause was neither complete nor immediate in 4; in 3 out of these 4 the amputation was above the internal os; in 39 cases, or 39 per cent., one ovary was saved and the menopause was neither immediate nor complete in 21; in 18 out of the 21 the amputation was above the internal os; in 21 cases, or 21 per cent., the menopause was neither immediate nor complete in 8; in 7, possibly all of the 8, the amputation was above the internal os. I do not doubt the wisdom in some cases of following his suggestion, but my observations do not justify me in crediting a continuation of menstruation after the complete removal of both ovaries. The continuation of bleeding, whether regular or irregular, in such cases is a coincidence, and probably the result of vascular changes by which the arterial tension is increased.

Wherever it is possible, enucleation of growths should be practised rather than hysterectomy, but the truth demands that I state I have never done enucleation in women under thirty-five years of age in whom fibroid growths have not recurred in some, necessitating hysterectomy for their removal. Such an operation is not always free from danger in subsequent pregnancy, as in those cases in which there is extensive injury to the uterine walls the cicatricial tissue produced may endanger rupture of the uterus in a subsequent pregnancy or labor. Any procedure which offers the patient an opportunity to escape from the distressing effects of the vasomotor disturbances incident to premature menopause is worthy of serious consideration. The degenerative processes in the ovaries and tubes, however, which so frequently complicate myomata, may render the preservation of these organs impossible. Ovarian hematoma in which the entire ovary is destroyed is a very frequent

complication of myomata. Aggravated arterial tension or marked muscular insufficiency may make the continuation of the menstrual function even from a decreased surface a source for prolonged hemorrhage. Another objection to the suggestion of Doran is the not infrequent association of malignant disease, either carcinoma or sarcoma, as a complication of myomata.

Mayo, Wallace, and Samuels in recent articles have advocated hysteromyomectomy or subtotal hysterectomy as the elective operation. Mayo quotes Bland-Sutton as saying that in 10 per cent. operation after the fiftieth year would be required for malignant complications, and Winter as asserting the relation of carcinoma of the cervix to the body is in the proportion of 15 to 1, and that this proportion is not increased in the cervix by the presence of myomata, while it is doubled in the body. Mayo gives his mortality for total hysterectomy as 3 per cent.; the supravaginal or subtotal, $2\frac{1}{2}$ per cent. Wallace advocates the retention of the cervix because its removal narrows the vagina in its normally widest portion at its upper end. He considers the supravaginal operation a simpler operation than pan-hysterectomy, as it requires less time and the control of fewer vessels. Samuels urges a pathologic examination of all growths removed because of the malignancy and degeneration which occur in them. I heartily concur with him in this advice, as in 66 recent cases in which such investigation has been followed, sarcoma was found in one and carcinoma in another, in both of which it would have been overlooked had not such an examination been made. The abdominal operation in fibroid growths is apparently attended with less danger than the vaginal. Döderlein, in 190 total extirpations by the vagina, lost 9 cases (4.7 per cent), while in 170 total extirpations through the abdomen there were 6 deaths (3.5 per cent.).

Carcinoma.—Strenuous efforts are being made the world over to determine the causes of carcinoma. It has been conveyed in mice and rats from one to another, and an opportunity thus afforded to gain some knowledge of the life-history of the cancer cell, but scientists are as much in the dark as ever as to the cause of the disease. Meanwhile the careful and extended study of vital statistics shows a well-marked and steady increase of cancer in every civilized country. Coley says that without any further increase the death-rate of cancer is appalling, and he does not believe that the actual death-rate is known, for physicians will often respect the prejudices of the family by assigning some other cause for death.

Etiology.—Levin says there have been three chronologic periods in the conceptions of medical men as to the genesis of cancer. The first period extended from Hippocrates to Virchow. During this period cancer was considered a diathesis and the tumor itself a parasite. The second period extended to the beginning of experimental cancer research. Virchow and Johannes Miller were the first to indicate that cancer consisted of normal cells and morphologically resembles benign tumors, the differentiation being the unlimited cell proliferation in the former. Virchow attributed this to an external irritant; Cohnheim, to the intrin-

sic abnormality within the cell; while Ribbert believed that every cell had an innate capacity for proliferation, but is restrained by cellular correlation. None of these theories were satisfactory. A new era was opened by Morau, Jensen, and Loeb in transplanting carcinoma in rats and mice. The interesting fact was found that when thus transplanted it will grow in not more than 10 per cent. Animals are more susceptible to the artificially grown tumor. The adaptability and virulence of the tumor cell gradually increases, so that the growth of the transplanted tumor depends on the virulence of the cell and the resistance of the host. Ehrlich, who has done most important work, has shown that when an animal is inoculated from a tumor of known low virulence the transplanted tissue will be absorbed without growth, and such animals were found immune against the majority of the virulent neoplasms; he called this panimmunity. It can be produced by inoculation with normal tissue, such as spleen, liver, and blood. It differs from any known form of antibacterial immunity. Levin has shown that this identical result has been secured with treatment of autolized tissue, that is, tissue in which the cells have been so killed as to leave the endocellular enzyme-like substance uninjured and active. Another point of interest in his investigations, confirmed by Bashford and others, is that carcinoma cells could originate sarcomatous cells, so it would seem evident that carcinoma and sarcoma are due to the same irritant, only exerting its influence upon cells of different character. It is to be hoped that the knowledge of how immunity can be secured in small animals may lead to methods of treatment that will cause the prevention or arrest of cancer. Experimental research has demonstrated that any cell can be transformed into a malignant one by an external irritant, and that a cancer cell may proliferate and retain its malignancy when transplanted into one host, and lose it and become innocuous when taken to another, hence it is evidently the interaction between the external irritant and the constitutional reactivity of the individual. Owing to the frequency of cancer of the womb and breast, it is found oftener in women than in men. It occurs at any age, but more frequently after the thirty-fifth year. The study of over 4000 cases by Levin affords no light on its contagion. The frequency of cancer of the uterus and breasts in virgins is respectively represented at 6.6 and 17 per cent. Cancer appears so infrequently among the American Indians that it would almost appear they enjoy immunity. The cervix is the most frequent seat of cancer, and is probably due to the greater number of injuries to which it is subject. Miller asserts that if laceration of the cervix is repaired there is no more tendency to cancer of the cervix than if the woman had not borne children. Theilhaber attributed cancer of the uterine body to anemia of the organ, and says that it occurs with advancing age. There does not seem to be any special relation between cancer and fibromyoma. Levin does not feel that the study of a large series of cases especially indicates that child-bearing has much influence. Indian women are more fertile than the whites, and yet cancer in them is comparatively unknown. Hendrick quotes Bashford as saying that vegetarians are no more exempt from cancer than those who live

on a mixed diet. Any theory explaining cancer must agree, (1) that statistically cancer is a function of age; (2) that biologically cancer is a function of senescence, and, one may add, of immaturity.

For **pathology** and **symptoms,** see Vol. V., pp. 530–535.

Cancer may have its origin either in the body or cervix, but in the former it is infrequent, and occurs as often in the nulliparous as in the parous woman. The growth is slow and for a long period is confined to the uterus. Cancer occurs in the cervix more frequently than in any other portion of the human body, and is more prone to be found in the parous woman, especially during the middle period of life. The growth in the cervix is rapid and extends beyond it by direct invasion or by metastasis at an early stage. Sampson in 1906 reported a careful study of 27 specimens from Kelly's clinic. Cancer was found in the perimetrium in 17; in 8 of these as direct extensions of thread-like processes or *en masse;* as metastases to the lymph-structures in 3, and in 6 cases both forms were present. In 19 of them cancer was found. He further directs attention to the classes of cancer as varying according to their origin from the epithelium, and, irrespective of this, into inverting and everting. The former is vegetating and the latter infiltrating. The everting form, developing from the portio vaginalis, presents a sessile or pedunculated tumor projecting into the vagina, and is less malignant than the infiltrating. In the inverting variety the deeper tissues are invaded and but little indication is found on the surface. This form is more frequent and more malignant. It invades the deeper structures, and soon extends beyond the uterus and involves the lymph-nodes by metastasis. When the disease proceeds by direct extension it may be either as delicate thread-like processes or *en masse.* He has found the nerve-sheaths in definite lymph-vessels and, more frequently, in the lymph-spaces. The parametrium is most frequently involved, often near the junction of the cervix and vagina. Here it is in close proximity to the bladder, and consequently it is difficult to secure a wide excision. The disease may extend anteriorly, posteriorly, or laterally. The former soon reaches the bladder, and laterally the tissues about the ureters. The reaction of these tissues varies between an increase in the connective tissue, inflammatory exudate, or no apparent change. In some cases such a reaction is due to the bacteria in the necrotic tissue and often to the cancer itself. In 41 cases the bladder was involved in 8, and in 7 of these at the level of the cervical junction. In careful investigation of the ureters the lower end is frequently compressed by the infiltrate, leading to hydro-ureter and hydronephrosis. Renal insufficiency from stricture of the ureters is a frequent cause of death; the structure of the ureter itself is very infrequently invaded.

Metastases.—These are found in four regional groups: the parametrium, the pelvic lymph-nodes, the abdominal lymph-nodes, and other parts of the body. The disease may be carried either by the blood-vessels or by the lymphatics; more frequently by the latter. When cancer invades a blood-vessel it may grow into it, filling up its structure, or portions may be carried to remote parts of the body. Mihälkovics,

discussing metastases, says they are found in one-third of the deaths from carcinoma. In 44 deaths after hysterectomy no metastases were found; in 202 deaths from recurrence, metastases were seen in remote organs in 9. Blau, Dybowski, and Wagner, in 255 cases, found metastases to the liver in 9 per cent.; the lungs, in 7 per cent.; renal metastases, in 3.5 per cent.

Diagnosis.—All authorities justly urge the importance of early diagnosis. There are three sites in the uterus in which cancer develops: the vaginal portion outside the external os; the cervical canal, between the internal os and the uterine body; from the internal os to the uterine ends of the Fallopian tubes. Hendricks directs attention to the following prodromes as important indications: (1) Bleeding in coitus may occur in vascular erosion, laceration of the cervix, endometritis and polypus, and is always suspicious; (2) metrorrhagia after the menopause may also occur in fibroids, polypoid disease, and senile endometritis; (3) a serosanguineous discharge resembling greasy dish-water or beef brine. This symptom is rarely found in any other condition than cancer. The clinical diagnosis depends on two factors: (1) The presence of a neoplasm, either a proliferation or an infiltration; (2) degeneration of this growth, which causes friability and is a characteristic symptom. Bleeding occurs in all three varieties, but is also found in erosions, endometritis, chronic metritis, and polypus. He further urges as a means of securing early diagnosis: (1) To educate women to regard any unusual hemorrhage or discharge after the menopause, or even before it, as a danger signal; (2) subject all patients to a most careful examination; (3) never temporize or delay. If unable to decide, have an expert and subject the suspicious tissue to the microscope.

Werder urges the importance of early recognition, and says that a slight discharge streaked with blood after coition, defecation, or exertion in a woman past fifty is suspicious. Hinchey urges the importance of irregular bleeding, and says that in a large number of cases observed during menstrual life only one did not give a history of menorrhagia or metrorrhagia as a symptom. Of all the cases occurring after the menopause, 67 per cent. gave a history of blood loss as a first symptom. Finally, he urges that any abnormal blood loss at any age should demand as rigid examination for the discovery of a possible cancer as any cough would demand for the discovery of a possible tuberculosis. McNaughton-Jones reports a case of extensive destruction of the cervix, while a single polypus was found in the fundus with no connection with the former. Microscopic examination of this disclosed solid carcinoma.

It is rare that patients suffering from carcinoma die from metastasis, hemorrhage, or sepsis. As in cancer in other parts of the body, it is generally from the complex condition indicated as cachexia. Offergeld indicates that in quite a number the urinary complication proves to be the cause of death. Simmonds found as large a percentage as 52 to 71 per cent. suffering from urinary complications. Offergeld in 1298 cases of cancer found metastases to the kidney in 31, or 2.39 per cent.

As the disease progresses the ureters become surrounded by the infiltrate which compresses them and leads to obstruction. This condition is the most frequent cause of uremia. Not infrequently the obstruction will become so marked that uremic coma is present, and then with disintegration of the mass the channel is re-established, and the patient passes the normal quantity of urine and retains her normal condition. The decreased mental activity and insensitiveness to her environment and condition induced by obstruction of the urinary current is often a fortunate termination to the disease.

FIG. 416.—INCISION IN PERITONEUM EXTENDING UPWARD TO AFFORD BETTER VIEW OF THE PELVIC VISCERA.

The experience of all operators in the treatment of uterine cancer is that the earlier it can be recognized and the slighter the manifestation when it comes to the surgeon, the better the prospect for the patient. It is most unfavorable when it has already involved the parametrial tissues, the uterus has become fixed, and the process of disintegration has set in. Unfortunately, few reach the operator in an early stage. This is due in part to the insidious onset of the disease, in part to the ignorance of the patients, and, sad to say, not infrequently to the neglect and want of consideration of the medical attendant. Every operation which does not succeed in removing all the diseased tissue is a failure. The wider the removal of tissue and the nearer we can operate within healthy struc-

tures, the more certain is a favorable prognosis. Emil Ries was the first to emphasize the importance of wide removal. The proximity of the bladder and the situation of the ureters limits the possibility of this procedure. The removal of the posterior wall of the bladder and the resection of the ureter in every case is, as Ries asserts, not to be followed. Extension from the cervix along the lymphatics is particularly treacherous, and may lead beneath the intact vagina to the lymphatic glands inside and outside the pelvis. Ries devised an operation in 1905 which has been variously modified and is known as the extensive Freund and the Wertheim operation. Its purpose is not only to remove the primary dis-

FIG. 417.—THE UTERINE ARTERY LOCATED BY PASSING A HEMOSTAT ALONG THE COURSE OF THE URETER LATERALLY.

ease, but the first metastases. The operation is a dangerous one, especially to anemic patients who have suffered from severe hemorrhages. In the performance of the operation it is important to keep in mind the bacteriology. All degenerating carcinomata contain micro-organisms of varying virulence. It is impossible to render a carcinomatous ulcer aseptic when once infected. Some operators have advocated that the cervix should be treated for some weeks prior to operation to render it in a fit condition, but such a plan of procedure affords time for the extension of the carcinoma, and it may thus spread beyond control.

The extent of involvement is determined by careful investigation. This may require the employment of careful digital examination, the speculum, and the cystoscope. When the latter gives indication that the disease has penetrated the bladder-wall, operation is contraindicated. Further contraindication may be determined by vaginal and rectal palpation. When these disclose involvement of the broad ligaments, parametrial tissues, and the bladder-wall, with extensive fixation of the uterus, the operation not only becomes dangerous, but useless. Uterine fixation may, of course, be the result of inflammatory exudate, either provoked by infection from the carcinoma or independent of it. After

FIG. 418.—PERITONEUM CUT ACROSS IN FRONT OF THE UTERUS, AND THE UTERUS AND THE BLADDER PUSHED BACK.

the abdomen is opened, nodules in the liver and omentum and infiltration of the intestines and peritoneum may render it unwise to proceed further.

The significance of enlarged glands is difficult to interpret, as they may result from the accompanying infection and not be cancerous. Firm attachment of glands to the veins is more than likely due to malignant condition.

Treatment.—*Prophylactic.*—In a disease so destructive to life as carcinoma, it becomes evident that the prophylactic treatment is of the utmost importance. Unfortunately, we do not know enough of the

causes of carcinoma and the conditions which favor it to be able to outline a satisfactory course of prophylaxis. C. H. Mayo directs attention to the influence of irritation in its production, hence the importance of removing all such sources. In line with this, lacerations of the cervix should be repaired and inflammatory conditions corrected. The only justifiable treatment in favorable cases of carcinoma is the entire removal of the organ, and this as thoroughly as the condition of the individual case will permit. The aim should be to remove not only the diseased tissue, but to go so far beyond the uterus that the tissues first invaded shall also be removed.

FIG. 419.—VEINS RUNNING ACROSS THE LOWER END OF THE URETER.
These veins should be cut between compressor forceps and both ends tied before opening ureteral sheath.

Both abdominal and vaginal operations have been employed. The latter is attended with a low mortality, but the operator is unable to get far enough away from the diseased structures to make sure of permanent cure. In other words, we have a low mortality from operation and a low percentage of survival for more than a few years. Peterson, Jacobson, Franz, and Zinsser urge the Wertheim operation, which is necessarily a prolonged one and attended with considerable danger. The technic of the operation is as follows: After thoroughly cleansing the vagina and the diseased tissue, the vagina is packed with gauze. Either the long median or the transverse incision through the superficial struc-

tures and the fascia may be employed. The intestines are walled back with gauze, and the uterus seized with fixation forceps and drawn up. The spermatic vessels on either side are fixed with two clamps, between which they are cut. Then the anterior fold of the peritoneum is split and the bladder pushed back. The round ligaments are tied and the folds of the broad ligament are pressed apart with forceps or the fingers, until the uterine arteries are exposed through their length. These arteries are freed of their connective tissue and are tied. The arteries and veins can be ligated together or separately. When the broad ligament is spread apart the ureter is seen lying on the median leaflet of the broad

Fig. 420.—Bladder Pushed Back, Exposing Upper Part of the Vagina, so that at Least One Inch of the Latter Can be Removed.

ligament. If the ureter is uninvolved, the operator satisfies himself as to its course. If there is infiltration around the uterine arteries, then the anterior peritoneum is cut transversely and the bladder separated. This can be done with forceps and the scissors until it is entirely free from the cervix and anterior vaginal wall. The bladder and the ureter are held away from the anterior vaginal wall. Care must be exercised not to cut the ureter; directly over it run one or two veins to the lateral surface of the cervix and vaginal wall. When these are cut and tied the ureter is exposed in its entire course from its entrance into the pelvis to the bladder. It must now be separated in order to permit the removal

of the tissue lying immediately beneath it, while at the same time the posterior leaflet of the broad ligament is divided at about midway between the stump of the spermatic vessels and the uterus. Beneath it and toward the pelvic floor lies the ureter, while toward the lateral wall it is less visible. The bladder with the ureters, according to the condition of the case and the extension of the carcinoma, is pushed to one side of the vaginal wall. The uterus is drawn firmly forward. If the bladder and ureter are far enough away, the uterus thus drawn up hangs by the vagina and enveloping connective tissue. The under half of the ureter

FIG. 421.—UTERUS DRAWN FORWARD AND THE POSTERIOR FOLD OF THE PERITONEUM SEVERED. THE SACRO-UTERINE LIGAMENTS CLAMPED.

lies to the side and extends forward into Douglas' fold. One can also in this tissue isolate the course of the larger vessels bluntly with two forceps, or with forceps and closed scissors. Some particularly large thick veins, known as the hypogastric, have their origin from the veins about the vagina and bladder. The bladder is held forward with a retractor, the vaginal wall is seized on either side with right-angle clamps, and cut transversely below them. As the vagina is opened the stump of the anterior wall is seized with forceps and stretched, which permits one to see into it, and any blood or fluid is carefully wiped out. One shoves against the entrance a gauze tampon, so that there will be no danger of

soiling the wound during the further procedure. Any bleeding vessels are quickly secured. As the vagina is drawn upward the paravaginal tissue can be removed if it is desired. This can be removed down to the levator ani, and any spurting vessel is at once isolated and seized. Care must be exercised in this procedure not to wound the ureter or rectum. Ligation here should not be made *en masse*, but the vessels should be isolated and tied. The next step is to remove all the connective tissue from the division of the iliac artery to the point of exit from the pelvis. The wound surface in the vagina is packed with strips of iodoform gauze which project to the vaginal orifice. In the lateral wound space no

FIG. 422.—CLAMPS PLACED ON VAGINA, BLADDER RETRACTED, VAGINA OPENED.

drainage gauze is used. Gauze in that situation increases the secretion and adds to the danger of necrosis of the ureter. Amann asserts that the ureters exposed in such a dissection are very prone to become necrotic, so he sutures the peritoneum over each ureter, and places between the ureters a rope of gauze which is brought through the vagina, and finally sutures the sigmoid over the pelvis, shutting it out of the peritoneal cavity. The anterior and posterior remaining peritoneal flaps are united by continuous sutures, and attempts are made so to protect the bladder that cystitis will not occur. The vesical peritoneum is sometimes sutured to the anterior vaginal wall.

Cystitis is a common sequel of the operation of carcinoma. Franz and Zinsser found only about 25 per cent. of their cases escape it. The cystitis is caused by so large a part of the bladder-wall being injured during the dissection. It is best treated by the employment of the continuous catheter for three or four days. Necrosis of the ureter with fistula formation also occurs from gauze drainage, and superficial injury to the sheath of the ureter, which although recognized during the operation, cannot be sutured over.

For four years they employed lumbar anesthesia with morphin-scopolamin sleep. This anesthesia lasts for an hour and a half or two hours,

FIG. 423.—REMOVAL OF UTERUS COMPLETED.

and the patient is not injured by the long-continued employment of chloroform or ether. Zinsser, analyzing Franz's cases, says of 70 cases from which the parametrium was removed, 9 died as a result of the operation, a mortality of 12.6 per cent. Of 41 of the remaining cases the disease recurred in 10 in the first year, in 8 the second year, and 4 in the third year following the operation, while 27 per cent. were still healthy after two or more years. In 82 cases with infiltrated parametrium and still movable uterus, 20 died, a mortality of 24.4 per cent.; recurrence followed in 28.8 per cent. of the remainder, and 20, or 24.4 per cent.,

were still healthy after two or more years. Of 21 cases with infiltration of the pelvic wall, the mortality was 33 per cent.

In analyzing the results of operations, in order to secure proper statistics, Winter has advocated the consideration of operations under the following heads: (1) Primary mortality; (2) percentage of operability; (3) permanent results after five years; (4) percentage of absolute cure. Jacobson says it is difficult to determine the percentage of operability, which varies with different operators from 10 to over 75 per cent. The radical operation renders a larger percentage operable, but neces-

Fig. 424.—All Raw Surfaces Covered with Peritoneum and Excluded from the Abdominal Cavity. Gauze Drainage from the Vagina.

sarily increases the mortality percentage. The percentage of death can be reduced largely by experience, but must necessarily remain high. The causes of death are shock, peritonitis, infection, sepsis, and injury to the ureters. Aulhorn gives the experience for the clinic for women at the University at Leipsic, on the duration of the recovery from cancer after eight years' trial with the radical operation. He considered it from three standpoints: (1) Conclusions from the general functional capacity in their operation for cancer; (2) an expression of the value of the abdominal total extirpation as opposed to the vaginal; (3) in what way the operative results can be improved. It comprises 641 cases of cancer of

the uterus, of which 221 were inoperable, making a percentage of operability of 65.7 per cent. This is in contrast with Glockner's statistics, which comprise 774 cases, with 260, or 26.69 per cent. operable. The percentage of operability of 65.7 per cent. is the average for seven years; it was 50 per cent. in 1902, and gradually increased to 80 per cent. in 1908.

The diagnosis of carcinoma in these cases was made by microscopic examination. The average age of the patient was forty-six to forty-seven years. The youngest was twenty-three years; the oldest, seventy years. In seven years the vaginal operation was done in 43 cases. In the earlier years all cases of carcinoma of the body were done by the vagina, and also in beginning carcinoma of the portio vaginalis, if the indications were against the abdominal procedure, as in fat abdomen or pulmonary complications; in late years, however, this condition has occurred infrequently. Of the 43 cases, 26 had cancer of the body and 17 of the neck; there were 4 deaths, a mortality of 9.3 per cent. Of the 26 cases of cancer of the body, 23 survived over five years. The recovery from the disease, according to Winter, is 47.7 per cent.

Abdominal Total Extirpation in Cancer of the Neck.—No attempt has been made to differentiate cases of cancer of the portio vaginalis from those of cancer of the cervical canal. There were 362 cases, with 51 deaths, a mortality of 14 per cent. In 342 of these cases the operation was done according to the Wertheim method, but in 20 cases, because of the fatness of the abdomen, the horse-shoe incision of Mackenrodt was employed.

The principal causes of death were peritonitis, 21; pulmonary emboli, 5; ascending pyelitis, 6; degeneration of the heart muscle, 5; croupous and bronchopneumonia, 5; from cancer-cachexia several weeks after the operation, 3; and from narcosis, acute dilatation of the stomach, cardiac weakness, postoperative hemorrhage, ileus, and ligation of the ureter, each 1.

Persistence of Recovery.—I. Group comprising those who have survived the operation for six, seven, and eight years. In this collection of cancer there were 255 cases, of which 117 were inoperable; 23 were operated on through the vagina, and 115 according to the method of Wertheim, showing an operability of 54.1 per cent.

Of the 115 cases by the Wertheim method, 11 died primarily, or 9.5 per cent.; 1 died from an intercurrent disease and 52 have remained free from recurrence, while 50 others, having lived over five years, are counted as recovered, which gives, according to Winter, a recovery from disease of 51 per cent.

II. Group of those surviving the operation from four to five years, of which 116 cases were collected; 37 were classed as inoperable, and the remaining 75 subjected to the Wertheim operation. The operability was 68 per cent. Of the 79 cases, 12 died primarily, a mortality of 15 per cent.; 2 died of intercurrent disease, 4 were missing, and 34 had suffered a recurrence, which gives an absolute recovery of 24, 5 per cent.

Aulhorn groups the cases in which the operation has been done more than five years into the following classes:

Prognosis I. Good: 10 times free from recurrence and 1 recurrence.
Prognosis II. Favorable: 35 times free from recurrence and 15 recurrences, 33 per cent.
Prognosis III. Dubious: 26 times free from recurrence and 25 recurrences, 50 per cent.
Prognosis IV. Extra Dubious: 13 times free from recurrence and 20 recurrences, 65 per cent.
Prognosis V. Bad: 5 times free from recurrence and 24 recurrences, 82 per cent.

Notwithstanding the bad prognosis, and cases in which infected glands were removed, 5 cases remained free from recurrence, and are of the greatest interest from the standpoint of operation and complete recovery.

It will be seen that the mortality of the operation increases with the higher percentage of operability, and the mortality is particularly high in the cases in which there has been intentional or unintentional injury of the adjacent viscera. These comprise:

I. Resection because of extension of the disease to the neighboring organs occurred in 11 cases, 3.08 per cent., of all abdominal operations.

(*a*) Three cases died primarily from peritonitis, which had been preceded in 2 by resection of the bladder and in 1 by resection of the bladder and both of the ureters.

(*b*) Two cases remained free from recurrence, 1 over five years after resection of the bladder and 1 over three years after resection of the ureter.

(*c*) Recurrence took place in 6 cases, of which 1 was a resection of the bladder and 5 cases of resection of the ureters.

II. Unintentional injuries occurred in 16 cases, 4.5 per cent., of all abdominal injuries, against 6.9 per cent. of the vaginal operations, as reported by Glockner.

(*a*) Primary death from lobar pneumonia followed in 1 case, in which the ureter had been divided and implanted in the bladder.

(*b*) Six in whom the bladder had been injured remained free from recurrence in 1 for over five years; in 1 who had the ureter injured and implanted in the bladder there was no recurrence in three years; 2 cases over two years, 1 with injury of the ureter and implantation into the bladder, and 1 with ureteral anastomosis.

(*c*) Recurrence had followed in 9 cases, of which 4 cases were injury of the ureter with implantation, 3 with injury of the bladder, and 2 with injury of the rectum.

III. Necrosis with fistula, of which there were 13 cases, or 3.64 per cent., of all abdominal operations.

(*a*) Three cases died primarily: 1 of peritonitis, with extensive necrosis of the ureters and bladder, and 2 of them with pyelitis after necrosis of the ureters.

(*b*) Five cases remained free from recurrence over five years, 1 after necrosis of the ureter, and the others following necrosis of the bladder.

In the 5 cases with fistula of the ureter or bladder all recovered spontaneously. Recurrence occurred in 5 cases, of which 4 were from necrosis of the bladder and 1 from the same condition in the ureter.

The most favorable cases are those which come to the operator within three months of the appearance of the symptoms, though in many of these it may have passed beyond the confines of the structures in which it originated. Comparison of the vaginal and abdominal operations shows that where the number of operations are nearly the same, the operability by the abdominal route is twice as great, while, on the contrary, the primary mortality is twice as high. The advantage of the

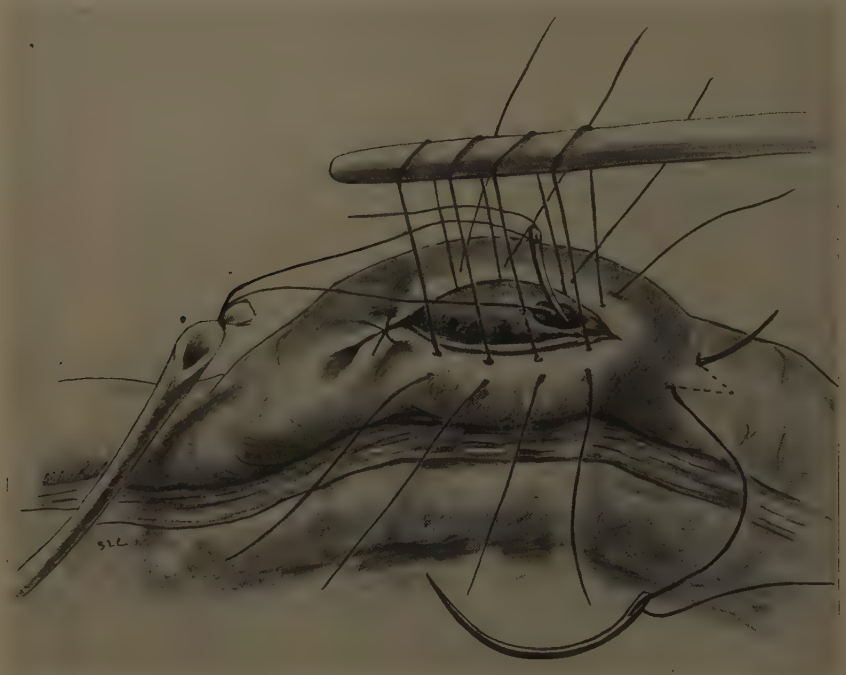

FIG. 425.—ILLUSTRATION OF URETERO-INTESTINAL ANASTOMOSIS AS SUGGESTED BY COFFEY. Ureter being drawn under the intestinal sutures through the stab-wound in the mucous membrane.

Wertheim operation is in the much greater number of absolute recoveries, which is more than three times as great as in the vaginal.

The method of transplantation of the ureter into the bladder is of great importance, for many of these cases die from extension of infection to the pelvis of the kidney. Sometimes the amount of the ureter necessary to be removed makes the subsequent implantation into the bladder impracticable, and it is in these cases, particularly when anastomoses has to be made with the intestine, that infection involves the kidney. In order to avoid such a possibility Coffey advises that the end of the ureter be split, a suture tied around one half, the loose ends threaded in needles and wrapped with gauze while the intestine is prepared. The part of

the intestine selected is incised through its peritoneal and muscular coats until its mucosa pouts out through the incision for an inch or more. Five or six sutures are passed, which pick up the peritoneum and muscular coats on either side, the suture at the upper end being tied as a control suture, the intestine is brought near the ureter and carried under the sutures named, and through a stab-wound into the intestinal mucosa, and out through the intestinal sutures, and through the stab-wound into the lumen. The ends of the suture are tied on the outside, thus securing the end of the ureter. The lateral sutures are now tied and the ureter is sutured to the coat of the intestine by two or three sutures, exercising care that they shall be superficial. Distention of the intestine occludes the ureter and prevents intestinal contents entering. These superficial sutures prevent dragging upon the attachment of the ureter through intestinal peristalsis.

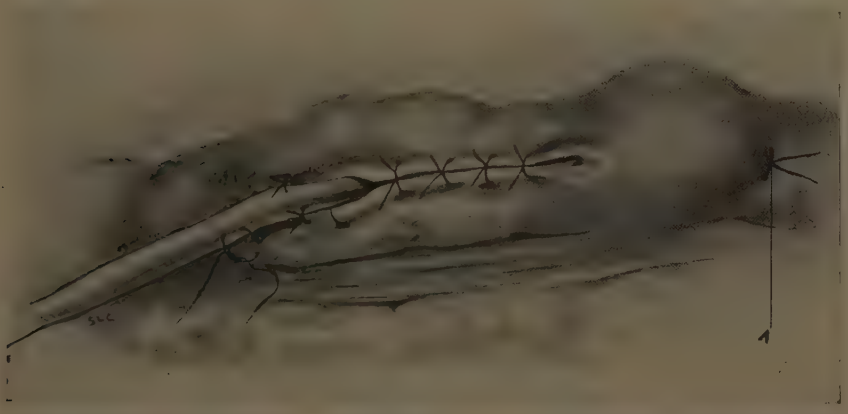

Fig. 426.—Operation Completed. Anchor Sutures to the Peritoneum: *A*, Traction Suture Tied.

The late C. C. Frederick deplored the fact that the majority of patients reached the operator too late—the large percentage of them were inoperable. Ineffective operations but hasten the growth. He advocated in such cases cauterization with the galvanocautery. He says the best results were obtained by holding the cautery not against but near the tissue and letting the heat penetrate it. By using a retractor over a wet gauze pad the bladder could be protected. He allowed no packing, as its removal prevented natural separation and promoted hemorrhage. The cauterization of the cervix prior to hysterectomy serves as a prevention of recurrence. A large class of cases in which the disease has passed beyond the realm of the knife has been subjected to various forms of treatment. The latest plan is that known as the DeKeating-Hart. The so-called fulguration has been enthusiastically advocated. John Berg considers this treatment as applied to 32 cases of cancer, and gives his opinion as follows: (I) Fulguration may afford temporary protection against extension of the tumor and that in cases which have gone beyond help by other means. (II) This influence is accomplished by in-

crease of connective tissue and not by destruction of the cells. The number of recurrences in loci and the number of advancing metastases are very great. (III) Dangers are: (1) infection, (2) extension of the carcinoma (*a*) by inoculation, (*b*) by the primary changes produced by the fulguration in the neighborhood of the carcinoma, (*c*) by the connective tissue forcing metastases into the deeper parts, (*d*) through following the paths of infection. (IV) Fulguration is, therefore, very unsatisfactory in its action, and in a large number of cases dangerous. According to Berg, it should only be used where operation and the *x*-ray are ineffective. (See Vol. VI., Chapter CXL.)

Sarcoma of the Uterus.—This condition is much less frequent than carcinoma. Dalton quotes Gessner as asserting that sarcoma of the uterus should be suspected: (1) When a tumor having the characteristics of a myoma does not cease to grow after the climacteric; (2) when such a tumor in a postclimacteric patient causes hemorrhage; (3) when with such a tumor a marked cachexia exists; (4) when with the tumor general symptoms arise which neither its size nor situation would usually cause; (5) when ascites is present and seems referable to the tumor; (6) with a rapidly growing, soft, or semifluctuating myoma; (7) when there is recurrence after the removal of a fibrous polypus.

Kakuschkin asserts that sarcoma belongs to the neoplasms, which are difficult to diagnosticate. They appear in various forms which greatly differ in their course, and are sharply differentiated from one another by their microscopic structure. Winter indicates that sarcoma occurs in about 9 per cent. of the cases of myoma. This diagnosis is not frequently made until the operation is completed, and consequently some operators have advised that the entire uterus be removed rather than do a supravaginal hysterectomy. Some tumors which have been proved sarcomatous by the microscope have not recurred even when the operation was confined to enucleation of the growth.

Many operators even in serious procedures, such as hysterectomy, urge the early getting up of the patient, and claim that it lessens the danger of phlebitis and promotes more effective drainage. In such cases and when the ventrum is weak following operation, the abdomen should be supported by strips of adhesive plaster passed the greater way around the trunk and holding in place an aseptic dressing.[1]

FALLOPIAN TUBES.

Disease of the Fallopian tubes, see Vol. V., p. 551.

The most frequent disorder of the Fallopian tubes is an inflammatory condition known as **salpingitis.** Crossen says the study of the condition justifies the following deductions: (1) Gonorrheal pyosalpinx, when the acute symptoms subside, may lie dormant and unsuspected for years. It may give no indication of its presence and the patient feel comparatively well. Pus-tubes seem to be tolerated just as any other small tumor in the pelvis; (2) such a quiescent pus-tube may at any time cause an acute attack of pain and disability. The onset may be so sud-

[1] Correction to top of p. 550, Vol. V.

den and apparently so causeless as to lead to the suspicion of ectopic gestation; (3) other symptoms of ectopic gestation, as missed menstruation, gastric distress, tenderness of the breasts, and softening of the cervix, which may add to the difficulty in the diagnosis; (4) gonorrheal salpingitis should be excluded; (5) in rare cases gonorrhea may pass rapidly through the uterus and tubes and produce peritonitis, with so little disturbance of the vagina and vulva as to give no indication of its presence. Such inflammatory conditions when they are allowed to continue result in closure of the abdominal end of the tube, the formation of a tumor from the collected secretion, and the loss of function becomes a prolific cause of sterility. Aulhorn quotes Zweifel as finding that intra-uterine injections of methyl violet solution were found at the ends of the Fallopian tubes. On this fact he began the treatment of cases of pyosalpinx and tubal inflammation by intra-uterine injections. The injection must call forth no serious reactions, so he employed a 2 per cent. solution of argentamin. This was introduced into the uterus with a sterile syringe having a cannula, which can be easily introduced into the fundus and slightly withdrawn when its full charge of 2.5 cm. of the fluid is injected. All stages of simple inflammation of the tubes, from simple salpingitis and perisalpingitis up to the fist size pyosalpinx, were thus treated. In order to obtain an uninfluenced decision no other treatment, such as baths or douches, was employed. Under this plan of treatment inflammation of the tube of a simple character so disappeared that it was no longer appreciable to the touch. Enlarged tubal collections decreased in size and no longer produced symptoms. In 123 cases thus treated with injections 108, or 88 per cent., were completely relieved of their symptoms. Improvement was observed in 7 others, while 8 showed no improvement. Of the pyosalpingitis cases, 86 per cent. recovered so far as subjective symptoms were indicated. It was not employed in acute conditions. One such acute case was treated, and appeared at once as a severe pelvic peritonitis. It should never be injected in patients with much elevation of temperature. Single injections were in many cases followed by severe colic-like pains, which in a few instances were severe enough to require morphin. It was found that after four or five injections pain entirely disappeared. The objective symptoms required a longer time to secure their disappearance. Rarely less than twenty-five to thirty injections and as high as sixty have been given. As injections were given daily, the treatment did not usually extend over four weeks. Five of the treated patients became pregnant. In cases of adherent retroverted uterus, where there was no inflammation, a solution (iodin. pur., 0.3; kal. iodid, 3.0; spirit dil., aquæ dist. āā, ad 100.0) was used. Where inflammation has gone on to destruction of the tubes, making it necessary to remove them, J. Munro Kerr advocates the removal of the uterus with the diseased adnexa. He says the uterus is merely a bag to contain the impregnated ovum and nourish it during the time it remains in the body of the woman. It contributes no internal secretion. Two conditions in which it should be particularly removed are malignant disease of the ovary and pyosalpinx. The frequency of

ovarian tumors is variously estimated as from 10 to 20 per cent. Kerr does not find the percentage so high in his experience. He removes the uterus in all bilateral ovarian cysts and in ovarian tumors when the condition is suspicious. One case of sarcoma of the ovary had to be operated on a year later for recurrence in the uterus and the other ovary; a second, where the uterus following an ovariotomy developed malignant disease nine months later. He had seen 2 cases of adenocarcinoma of the uterus with carcinoma of the ovary. In pyosalpinx it was the custom formerly to remove the pus-tubes only, but so many cases occurred in which discomfort arose in the uterus as a result of its retention that a second operation was done in order to give the patient comfort. He has been following this course for the last two and a half years and finds the result satisfactory.

Leakage from the tube or its **rupture** frequently results in a diffuse suppurative peritonitis. Bovée reports a case of peritonitis from ruptured pus-tubes. He says the condition is most dangerous when the tube is distended with infected pus. The gravity of the condition is seen in the high mortality (58 per cent.) attending it. The rupture may occur from violence of some form, as child-birth, curetment, or even examination of the patient. Peritonitis rapidly follows, indicated by excruciatingly severe pain, perhaps a chill and collapse; there is fever and thready pulse and all the symptoms of peritonitis. The result will depend upon the resistance of the patient and the method of treatment pursued. Of 18 cases not subjected to operation, all died; they survived from a few hours to three months; 38 underwent operation, of whom 14 died, a mortality of 37 per cent. Pallin says that gonorrheal peritonitis can arise in the tubes in one of two ways: the bursting of a tubal collection, as a pyosalpinx, or an ovarian abscess. It is extremely rare that an infection passes directly through the tubes. Kosmak urges the danger of irrigation of the uterus, and relates a case in which irrigation was followed by section, showing the belly filled with bloody solution which evidently had entered the abdomen through the Fallopian tubes. The patient had a stormy time, from which she ultimately recovered.

The collections that are generally found in the tube are serum, pus, and blood. The tumors thus formed are known as **hydrosalpinx, pyosalpinx,** and **hematosalpinx.** The latter is generally attributed to ectopic pregnancy, but A. Louise McIlroy indicated the possibility of its occurrence from torsion of the Fallopian tubes, and recounts the history of a case in which she was in doubt prior to operation as to the diagnosis between ectopic pregnancy and incarcerated fibroid. The operation disclosed it to be a hematoma from a twist in the tube. Hematosalpinx may arise (1) from ectopic gestation. Indeed, this is its cause in the great majority of cases, but careful investigation should be made as to the embedding of the ovary. Rupture of the tube in hematosalpinx is exceedingly rare, and the abdominal ostium is usually closed, while it is open in abdominal abortion unless closed by recent adhesions. (2) Hematosalpinx may be associated with uterine pregnancy. This

is generally attributed to a reflex of blood from general congestion. (3) Hematosalpinx arises from atresia of the genital canal. This may be caused by malformations and tumors. Katz cites 16 cases of hematometra in the uterus bicornis unicollis. (4) Tubal menstruation may be productive of the condition. Vaughan found that blood was situated in the tubes of the patient the first day of the menstruation, but twenty-four hours after cessation there was none. The objection that the blood has come from the uterus is met by the fact that the tubal inflammation precedes that of the uterus. (5) Inflammatory conditions and tumors of the tubes will cause hemorrhage in some cases. (6) Disorders of circulation, as increased pressure from arteriosclerosis, rupture of the utero-ovarian plexus of veins from varicose conditions, and hemorrhage in fibrosis of the uterus, are frequent symptoms.

Torsion of the Pedicle.—Torsion may occur in the ligamental attachment of any organ in the abdomen except the liver. It may take place gradually or suddenly. Various theories are offered for its occurrence, but the cause is unknown.

Cassidy and Norberry report a case of torsion of the left broad ligament and the Fallopian tube in a child aged eleven years. The patient underwent operation for supposed appendicitis, when a mass was found which was with difficulty extracted. Examination disclosed that the broad ligament had undergone several twists close to its uterine attachment. The tube and ovary were black and the broad ligament infiltrated with blood-clot. Careful microscopic examination failed to disclose disease of the ovary. Damianos reported 14 cases of torsion of the uterine adnexa in inguinal hernia of young children, and Morrel, a case of torsion of the left Fallopian tube in a woman aged thirty-two years without the accompanying ovary being affected. Haultain reported a case of apparently chronic torsion of the Fallopian tube and broad ligament with infarction of the ovary, for which operation was occasioned by a metrorrhagia of eighteen months' duration.

Actinomycosis of the uterine appendages has been reported by Carl Wagner. He says no cases have been reported in this country, but 24 in Europe, and he thinks this failure due not so much to the scarcity as to a want of careful investigation. Many cases resemble tuberculosis and are called pseudotuberculosis. Schabad differentiates the condition as follows: Actinomycosis typica produces pus with corpora flava, which is acid-fast; actinomycosis atypica produces pus with corpora flava and is acid-fast. Of the latter there are two varieties, actinomycosis atypica simplex, which liquifies gelatin and produces in animals a pseudotuberculosis, and actinomycosis atypica, a pseudotuberculosis which does not liquefy gelatin and produces pseudotuberculosis. Wright, after many inoculations from fifteen different sources, found that the micro-organisms of actinomycosis presented but little infective activity. Hamm reproduced the disease in animals after the injection of pus of actinomycosis. Hueppe found that the injection of actinomycosis pus in tuberculous animals easily kills, while tuberculosis injections in animals suffering from actinomycosis exerts no effect. It is difficult to see how

the disease in the ovary can be primary. H. E. S. Thompson attributed his cases to vaginal infection, but this is opposed for the following reasons: (1) Actinomycosis has not the power and quality of the spermatozoön; (2) actinomycosis, so far as known, does not move by the lymph route; (3) it is doubtful whether it utilizes the blood-current in its transmission; (4) Partsh and Israel's research work indicates that it spreads by infiltration, penetration, continuity, and contiguity; (5) it is improbable that the microbe should travel so long a distance as from the vulva to the tube without previously finding a nesting place for its development. More probably the soil contaminated with actinomycosis reaches the affected structures through the intestinal tract by adhering to salad, fruit, and vegetables. The intestines may at the time be favorable to the habitation and cultivation of the micro-organisms. In all the cases reported the intestines were firmly adherent to the appendages. He concludes that actinomycosis is probably a secondary infection taking place in the intestinal tract, and most frequently from the appendix. The secondary infection occurs by infiltration, penetration, continuity, and contiguity, and where long existent is surrounded with dense connective-tissue formation which may lead to erroneous diagnosis of different kinds of tumors, and presents a picture macroscopically and microscopically resembling tuberculosis.

Wound Closure.—Surgeons have experienced great difficulty in closure of abdominal wounds in such a way as to prevent subsequent hernia. With a through-and-through suture the number of herniæ were about 30 per cent.; under improved methods these were reduced to 8 per cent., while suturing was done in layers. Some have advocated that the incision be made to one side, but Mikulicz demonstrated that this course, by dividing the terminal nerve branches, may result in paralysis and atrophy of the rectus muscle and increase the danger of hernia. Lange has shown that the skin fibers run transversely, hence when divided at right angles they tend to widen the scar; on the other hand, a transverse incision spreads but little. Pfannensteil took advantage of this atomic fact and made an incision slightly transverse, 6 to 8 cm. long, about 6 cm. above the symphysis through skin, subcutaneous tissues, and the anterior sheath of both recti muscles. The sheaths were then bluntly dissected upward from their attachments to the recti muscles. The attachment to the linea alba was divided with scissors, after which the linea alba was divided vertically and the abdomen opened in the usual way. It has the advantage over the extramedian incision that no nerves are divided, and consequently no muscular atrophy can occur. The surface can be closed with continuous sutures in layers. Pfannensteil recommended a flat sand-bag 6 to 8 pounds laid over the dressings for ten to twelve hours. The advantages claimed for this incision are (1) the avoidance of postoperative hernia; (2) the lateral and anterior parts of the field are more accessible. The situation of the incision is lower and the muscles separated from their sheath are like rubber bands and easily separated; (3) patients can rise sooner than with a vertical incision, as the intra-abdominal pressure does not affect the skin and

fascial incision. Elderly patients may sit up on the third or fourth day; (4) it is unnecessary for patients to wear an abdominal belt.

THE OVARY.

J. Prescott Hedley, in a report of 18 cases of **hematoma of the ovary,** says this condition is but little noticed in the text-books, although it is comparatively common in the child-bearing period and is frequently bilateral. Its signs and symptoms are so ambiguous as to cause it to be mistaken for such conditions as chronic salpingitis, tubal gestation, uterine fibroids, and appendicitis. It is frequently the cause of chronic pelvic pain indefinite in position. The swelling may be so small in amount that without careful examination the condition could be attributed to a neurosis. When established the condition seems to be progressive. The ovary is enlarged, filled with old, altered, tarry red blood, brown in color, and of the consistence of syrup, containing a number of brown solid particles from pin-head size to that of a grain of wheat.

Clinical Features.—It occurs in the child-bearing period. In the 18 cases the youngest was twenty-four years; the oldest, fifty-three years; the average, 38.2. The majority of the women were married between twenty and twenty-five years; 8 of this list were unmarried women, and in but 1 was there any probability of vaginal infection.

Pregnancy.—Of 10 married women, 4 had never been pregnant. 1 had three children, another two, and 3 had each had a child and a miscarriage; the remaining patient had one child; none of the single women had been pregnant. The average of pregnancies among the married was 1.2, so that it appears the conditions which cause hematoma of the ovary predispose to reduce fertility. Menstrual disorders are common. In 9 there was menorrhagia, and in 2 others profuse flow; 5 of them had uterine fibroids, which may have been the cause. Intermenstrual bleeding occurred in 1, and in it the pain over the ovary and the bleeding were simultaneous. Two patients had amenorrhea when admitted, one for two, and the other for three, months. Pain at the period was a common complaint. In 5 there had never been any menstrual pain; in 1 habitual pain was always relieved by the flow. In 4 cases there had been well-marked dysmenorrhea from puberty; in 4 cases dysmenorrhea was acquired. One had reached the menopause and had suffered from dysmenorrhea for three years. Pain was the most prominent symptom in all except 2, who were operated on for fibroids. The character of the pain varied. As the first symptom there was a sudden attack of pain, usually at the lower abdomen, with vomiting retching, and fever.

The physical signs vary with the size, thickness of the surrounding wall, and amount of peritonitis and cellulitis. In the examination the swellings varied from a cocoanut to the size of a hen's egg. In 4 the tumors could be moved to a slight extent, while in 9 they were fixed. These tumors are usually so fragile that they nearly always rupture in the effort to separate and remove them. The hematoma nearly always ruptures in its separation. One or both ovaries may be involved. In 9 the

condition was unilateral and in 6 bilateral. The walls of the sac vary in thickness, sometimes ¼ to ½ inch thick, and in others the thinness of paper. Smallwood Savage divides them into two varieties: (1) hematoma of the Graafian follicle, and (2) hematoma of the corpus luteum. In the first the walls of the hematoma are lined with a single layer of epithelium lying on a basement membrane, external to which were two layers which correspond to the theca interna and the theca externa. In the second type there was a shell of ovarian tissue, the inner wall of which showed newly formed fibrous tissue poor in cells. In the majority of cases the Fallopian tubes were not disordered. Ovarian pregnancy has been offered as an explanation, but Griffiths and Williamson, who made it, were unable to present any evidence in its favor. The fact that so many unmarried women suffer from hematoma is against the view.

Ovarian Cysts.—Horsley discussed a list of 25 such cases collected by James S. Bullitt, the largest of which was that reported by Cartledge, weighing 245 pounds. The patient succumbed on the seventh day. In Horsley's case the cyst weighed 116½ pounds; the patient recovered. The large cysts are of the glandular, proliferating variety. Reginald H. Lucy reported a case of double dermoid cyst of the ovary with rupture into the peritoneal cavity. In a single woman aged thirty-two years, who had noticed a swelling of the abdomen when eleven years old, puberty followed at the age of fifteen, and she had suffered a severe attack of pain in the left side when nineteen years of age; the operation disclosed that the deeper layers of the incision were thickened and opaque and a material closely resembling lanolin filled the abdomen. Eleven pounds of this greasy material was scooped out with the hands. A cyst was found at the upper part and from it projected a broad band like a bowel. An opening in the upper part of the cyst permitted the escape of the material which filled the abdomen. When the band was separated it was seen to be the remains of the omentum. The cyst, when lifted out of the abdomen, was found to be connected with the left side of the uterus. The abdominal wall was covered with the greasy deposit and a patch of hair projected from the peritoneum at one point, which was dissected off and several drains inserted in closing. The patient recovered after an irregular convalescence. The patient and the operator in this case were particularly fortunate, as the contents of dermoid cysts are extremely irritating to the peritoneal cavity. It is always wise in their removal to deliver them without reduction. Jones and Eccles report the spontaneous rupture of an ovarian cyst in a nurse 6 feet tall who weighed but 139 pounds. She retired to bed in usual health and awoke as usual at 6 o'clock the next morning, but in turning in bed was taken with violent pain. She dressed and proceeded on her rounds as usual, but the pain became so severe that she returned to her room and fell unconscious. At midnight, eighteen hours after the onset of the condition, the abdomen was opened without any definite idea as to the condition. A glairy material was discharged different from what would occur from a perforation of the abdominal viscera, and a collapsed

ovarian cyst was found springing from the left ovary. The patient recovered without trouble and remained well.

Some years since I saw, with the late Pennington, of Atlantic City, a case in which he had performed paracentesis for abdominal distention without obtaining any fluid. I examined the patient and was convinced that she had free fluid in the abdominal cavity. When Pennington asked why he had been unable to obtain it, my reply was that "It was probably too thick to pass through your cannula." I opened the abdomen of this patient and found it to contain between 2 and 3 gallons of jelly-like fluid which had escaped from a collapsed ovarian cyst, with walls so thin that it was not recognizable by palpation as it floated in this fluid. The patient recovered, but some four years later I was called to see her to find her suffering from an abdominal carcinoma which had broken through the posterior fornix of the vagina, forming a cauliflower mass behind the uterus.

W. Nagel, in discussing papillary ovarian cyst, asks, "Should both ovaries be removed?" Almost one-half of papillary tumors of the ovary are adenocarcinoma, and may be either unilocular or multilocular. The papillary cystoma serosum is unilateral in 33 per cent. and bilateral in 67 per cent. Glockner found the bilateral in 60 per cent. of all his cases. In 34 women with papillary cystoma, 18 had no recurrence, 45 per cent.; cases of papillary adenocystoma, 31, or 83 per cent., were alive five years afterward. Of Hofmeier's 30 cases of unilateral ovarian cancer, 15 died in the course of eight years after the operation; 7 of them with carcinoma. Pfannensteil and Glockner advocate the removal of both ovaries when one is the seat of cancer. Of Nagel's 2 cases of ovarian cancer with unilateral ovariotomy, one was living and well eight years afterward, and the other died of pneumonia seven years subsequent to the operation.

Rosenstirn directs attention to the secondary implantation of carcinoma in the ovaries, and asserts that Bucher was the first to accept this theory, and attributed it to primary affection of the stomach. Heinriche warned against incomplete operation for carcinoma of the ovaries when the primary tumor is not apparent. Schlagenhaufer, in an analysis of 79 cases, showed that secondary carcinoma of the ovaries is relatively frequent. Sternberg asserted that the growths of the stomach, the primary origin of the trouble, were often so small as even to be overlooked at the autopsy.

Glockner, Pfannensteil, and Hofmeier are in accord with the view of Schlagenhaufer. Their views differ as to the manner in which the metastasis occurs. These views may be summarized as follows: (*a*) Through the blood circulation in arterial and venous retrograde direction; (*b*) through the retrograde lymphatic glands; (*c*) by graft implantation. Experiments of Kraus led him to regard implantation as impossible. Wolfheim opposed his view, and gave the following reasons: (1) That the intact germinal epithelium of the ovary offers secure protection from the advance of corpuscular elements in the abdominal cavity; (2) that the slight physiologic injury even of the epithelial covering of the ovary as

it occurs in every ovulation renders their immigration impossible; (3) that in his own statement Kraus' experiments cannot be accepted as free from objection. Investigations of Sitzenfrey, Glockner, and others, however, favor the implantation theory. They say it is unnecesary to have a break for the exit or entrance of the infection; the material is carried by gravity and the peristaltic action of the intestines. Sitzenfrey advocates the removal of the normal ovary in carcinoma of the stomach, and also says that carcinoma in the abdominal cavity may cause an implantation metastasis in the pouch of Douglas, which occurs earlier than in the ovaries. The metastasis is influenced in its action by the law of gravity and affects first the deepest part. It is unnecessary in such cases for the primary carcinoma to have penetrated into the free abdominal cavity, and in radical operation for carcinoma the deepest portion of this pouch should be removed. It is in line with these views that Dudley A. Palmer urges rectal investigation in every case of carcinoma of the higher viscera of the abdominal cavity as an indication as to its operability.

Cohn considers the occurrence of cancer in the ovary as metastatic when the disease coexists in other organs. This is especially true in colloid carcinoma of the ovary with cancer of the stomach. The operative treatment of the ovary necessarily depends upon the primary origin of the disease.

Salpingo-oöphoritis.—It is impossible to differentiate the treatment of inflammatory diseases of the ovaries from those of the tubes. Indeed, an acute inflammation of the one organ is rare without the involvement of the other. Goth, in a review of 700 cases, from which, as far as possible, tuberculous cases were excluded, asserted that gonorrhea was the principal cause of most of the adnexa diseases, whether without, or in relation to, the puerperal processes. Of the 700 patients, 418, or 59.71 per cent., were married; 23, or 36.28 per cent., widows; 5, or 71 per cent., separated from their husbands; 254, or 36.28, single. In about one-third of all the cases of adnexa disease sterility is a result. Of 219 who suffered from hemorrhage, it soon ceased under absolute rest in bed, although in a few it was followed by continuous bleeding. Among the entire number of cases there were but 24 who did not complain of pain; 16 of these complained only of bleeding, and 4, only of discharge. One came to the clinic for prolapse and another for bartholinitis. The inflammation, contrary to the general teaching in the text-books, did not seem to affect the time of menstruation nor to increase or advance the flow. In 64 cases in which fever characterized the stay of the patient in hospital, the highest average temperature was associated with the largest size growth. In 165 cases in which were found complicating conditions of the genito-urinary organs, retroversion and retroflexion were most frequent, and were recognized in 124 cases; cystitis came next, with 13, and parametric exudation was seen in 12. It is probable that the greater frequency of retrodisplacement is due to the tendency of the inflamed and enlarged adnexa to fall back into the pelvis and draw the uterus back by the formation of adhesions. Goth's investigations, however, led him to

believe that in but 3 of the 124 cases had the retrodisplacement arisen from an inflammatory condition. In some cases the inflamed adnexa became so large as to correct the pre-existing displacement of the uterus. The inflammation processes were double-sided in 601, 85.72 per cent.; one-sided in 99, or 14.28 per cent. Single tumors were found on the right side in 50; on the left, in 47. This difference is not sufficient to indicate that appendicitis has anything to do with the development of the condition on the right side. Goth never saw a case of tumor of the adnexa which had begun with symptoms of appendicitis, and saw no single case which he believed had probably originated in an attack of appendicitis.

Therapeutic Measures.—As long as inflammatory conditions predominate, therapeutic measures should govern. Uninterrupted rest in bed should be the first consideration, and while the parts are tender to pressure the ice-bag should be applied. In acute cases the ice-bag should be continued uninterruptedly, but later, when less stormy, night and morning for a period of about two hours, and in the intervals the Preisschnitz fomentation. These applications at night are very acceptable as a substitute for the ice-bag. Where the tubal loop or exudate is near the vagina, that passage may be employed, using twice daily 20 liters of water. This cooling method is very valuable in fat abdomens. The maximum time for employment of the ice-bag was one hundred and seventy days; the minimum, six days. After the acute sensibility disappears and the temperature remains normal, the treatment is directed to the promotion of absorption. This consists for a few days of the Preisschnitz fomentation exclusively in order to permit the parts to react from the cold. If the sensibility increases or the temperature is elevated, return to the ice-bag; if the warmth produces no unfavorable symptoms, begin with hot douches. These douches should begin with a temperature quite as high as can be borne, which is increased each alternate day by one degree until 110° to 112° F. is reached. These hot injections can be followed by ichthyol tampons, which are placed in the posterior fornix of the vagina every second or third day when the vagina is sensitive, and removed in twenty-four hours. A 10 to 20 per cent. solution of ichthyol in glycerin can be used. If the hot injections are not effective or the general condition of the patient is not improved, warm baths (96° to 104° F.) should be employed. In 17 cases the injections produced decided reaction, fever in 15, and pain in 2. The fever occurred ten times in the first week, three times in the second, and twice in the third, after the injections were begun. The hot injections have been thrown into the background by the introduction of hot air. Vertes, in 14 cases thus treated, of which in 9 the tumor was fist-size, in 1 it decreased to the size of an apple, in 3 there remained a perceptible nut-sized ovary and a well differentiated tube; the size of the tumor was unaltered in 5 cases, except that it became more circumscribed and freely movable. The result of the air treatment is mostly limited to diminution or increased mobility of the adnexal tumor. It is likely to be followed by a slight yellow discharge produced by the resulting hyperemia, and it is wise to warn the

patient of its possible occurrence to prevent her being alarmed. In 39 cases hot-air treatment in 29 immediately followed the ice-bag. While the hot-air treatment has been added to our armamentarium for the treatment of inflammatory adnexa, it is important that the cases be carefully selected, as it best exercises its action in proportionately fresh cases. Massage is employed in proper cases, but it is preferable for the restoration of fixed retroversion of the uterus. In febrile or sensitive cases massage is injurious. The high temperature of the patient affords no indication of the ultimate curability of the case. Those with high temperature are as favorable as those with fever-free course. Perforations into the neighboring organs were observed in 5 cases, 4 of which were into the intestines and 1 into the bladder.

Okinczyc, in discussing metastatic oöphorosalpingitis, is inclined to combat the view that gonorrhea is responsible for all inflammation of the adnexa, and says, independently of gonorrheal, septic, and tuberculous infections, the infections in general have affected the ovaries and tubes. The infections reach these structures by ascending the canal from a primitive endometritis, by peritoneal contiguity, intestinal or appendicular, by the lymphatic path, and by the blood-vessels, either the arterial or venous. Grip infection reaches the tube and ovary through the blood. The poisons of scarlet fever, measles, smallpox, diphtheria, erysipelas, dysentery, and hydrophobia have all been considered responsible for tubo-ovarian disease. Slaviskanski reports ovarian inflammation produced by the poison of phosphorus, arsenic, and mercury. Scarlatinous suppuration of the tube is frequent, and has been reported by Lededinsky and Eastman. Galliard and Beaussenat report a case of developing peritonitis from measles. Peritonitis has developed from the rupture of a small abscess in the right ovary. The corresponding tube had been thickened and dilated. Rendu thinks that the measles favored the secondary infection and did not furnish it. Inflammatory disorders of the tube and ovary have been found associated with variola, mumps, tonsillitis, typhoid fever, and syphilis. Inflammatory conditions have been found also associated with parasitic conditions.

The after-results of abdominal operations, not only in inflammatory conditions, but where neoplastic growths and displacements demand such treatment, is of the very greatest importance. It is not unusual for the surgeon to impress his patient and her friends with the necessity for the exercise of the greatest prudence and care following these operative procedures. I am convinced that it is often overdone, and the patient is given an exaggerated idea of the necessity for caution in making any exertion for some time subsequently. In my experience those patients recover the most rapidly who are obliged by the necessity of supporting themselves and others to forget their physical condition in the multiplicity of their cares, and I am more desirous of getting the patient employed and her mind occupied than I am of devising ways to keep her quiet. Arthur E. Giles reports the study of the after-results in 1000 abdominal operations. The list comprises (1) unilateral salpingo-oöphorectomy, (2) bilateral salpingo-oöphorectomy, (3) abdominal hysterectomy, (4)

hysterectomy and unilateral salpingo-oöphorectomy, (5) total extirpation, (6) conservative operations for fibroids, (7) operations for displacements. In the 1000 cases there were 41 deaths. Of the remainder, 771, or 80 per cent., were traced. The questions particularly sought to be answered were: (1) How was the general health after abdominal operations? (2) What was the duration of the period of invalidism? (3) How is the memory affected? (4) In what proportion of cases was further operation required? (5) What are the prospects of a subsequent pregnancy and labor? (6) In what proportion of cases is there trouble with the scar?

In answer to the first question, as to the general health after operation, 23 died later; 10 from recurrence of malignant ovarian or uterine growth, 2 from intestinal obstruction, and 1 from generalized tuberculosis. These 13 cases may be considered to have died from operative sequelæ, the other 10 from independent causes. Excluding these cases and 18 patients who underwent re-operation, there are 730 cases available, 90 per cent. of these having very good health or better than they had known immediately before the operation.

Regarding the second question, as to what was the period of invalidism after operation, of the patients seen two months later about five-sixths were invalids or semi-invalids and about one-sixth were well. At the end of three months the invalids and semi-invalids counted two-fifths, and three-fifths were well. Of the patients in the first two months, those under thirty were all well or semi-invalids. Of those under forty, 6 were well or semi-invalids, and 2 were invalids. Those over forty were both invalids. Between two and a half and four months 70 per cent. of those under thirty were well, and the other 30 per cent. were semi-invalids; under forty years 64 per cent. were well and 36 per cent. invalids or semi-invalids; over forty, 53 per cent. were well and 47 semi-invalids. It is evident that those who recover do so within the first three or four months, and while some of the others recover, a fair number are semi-invalids at the end of twelve months. The gravity of the operation does not seem to influence the recovery adversely. The least rapid convalescence seems to follow the conservative operation, as myomectomy and hysteropexy, the unilateral salpingo-oöphorectomies; next, the total extirpations, while the most rapid are after hysterectomies for fibroids and double ovariotomies. Generally, the younger the patient, the quicker the recovery.

Third question, How is the memory affected? Memory seems to be lessened in about 25 per cent. of the cases. The impairment is the more marked, the longer the duration of the operation. It is due to prolonged anesthesia and is an argument for expedition in operating.

Fourth, In what proportion of cases is further operation required? There were in all 64 cases requiring further operation, and they can be divided into two classes: first, those in which the operation can be considered as a sequel of the original procedure; second, where the operation is demanded for conditions independent of the first operation. In the first class there were 30 operations, 17 of which were for scar-hernia, 2 for

long discharging sinus, one of which followed operation for a large suppurating broad ligament cyst treated by marsupialization, and the second led down to the left ovary, which had been converted into a pus-sac. The sinus closed with the removal of the ovary. In 4 cases an exploratory operation was done for persistent pain. In 1 case hysteropexy had been done and a cystic ovary removed. Adhesions of the omentum existed, which were broken up. In 2 cases interstitial adhesions were found and separated, and in the fourth nothing was found; but this, like all the others, recovered after an operation. In 1 case operation was undertaken because of intestinal obstruction from adhesions. In 6 cases of operations for displacements, the condition recurred; 4 were treated by refixing and 2 by hysterectomy. These latter cases are not so much sequelæ, as failures. The sequelæ were traced in 24, or 3.1 per cent., of the cases. The largest number of these was found to follow diseased appendages, which was 8 per cent. These are the cases in which there is the greatest probability of trouble from adhesions, infected stitches, and weakened scar from long-continued drainage. The second group comprises 35, of whom 8 were for tubal pregnancy after one ovary and tube had been removed for ovarian tumor, inflammatory disease, or previous tubal pregnancy. Six were for ovarian cysts after unilateral ovariotomy; 7 for inflammatory tubal disease, in 5 of which the tube of the opposite side had been removed; 5 were hysterectomies for fibroids, in 2 of which both appendages had been removed for previous inflammatory disease of the tubes; in 2 a previous myomectomy for fibroids and a hysteropexy had been performed. The remaining 8 were a miscellaneous group comprising 1 each for myomectomy, colostomy, cancer of the sigmoid, exploratory operation for cancer of the sigmoid and bladder, hysterectomy for fibrosis, resection of the bladder for cancer, gall-stones, appendicitis, hysteropexy in a case of previous tubal pregnancy, and 1 the nature of which was unknown. Patients who have undergone abdominal operations are more exposed to later trouble than those who have not had such experience. The risk of sequelæ is greatest after inflammatory disease.

The fifth question, as to the chances for subsequent pregnancy and labor, must necessarily be applicable to a limited number, especially those in which the appendages of one side only have been removed, and to the married. It may be considered under three phases: (1) What are the chances for subsequent pregnancy? (2) What are the chances for pregnancy at full term? (3) What are the chances for labor being normal?

In answer to the first question, the prospects for conception after the conservative operations were shown to be good. The smallest number of subsequent pregnancies was in the cases in which the appendages of one side were removed for inflammatory disease, in which it was 21 per cent.; when one ovary was removed for tumor, 24 per cent.; when the tube was removed for tubal pregnancy, 39 per cent. In answer to the question as to the probability of pregnancy going to full term, in 35 cases where pregnancy occurred after the removal of the appendages of one side, 8

developed tubal pregnancy, while there were 30 pregnancies in the remaining 27; 5 of these were in progress when last seen, 24 went to term, and 7 ended in miscarriages. It would seem, therefore, that 77.4 per cent. went to term. Of the other group there were 53 patients who had an aggregate of 66 pregnancies; one of these was extra-uterine. The woman had undergone a hysteropexy combined with an ovariotomy. In the remaining 65, 4 were in progress when last seen, 45 went to term, and 16 ended in miscarriages. The percentage of those going to term was 73.3 per cent. These statistics would indicate that the tendency to miscarriages after uterine operations is slightly greater than when done for unilateral removal of the appendages. The operation during pregnancy did not seem to lead to its interruption.

Third, as to the chances of labor being normal, among the unilateral salpingo-oöphorectomies 15 were full-time pregnancies and 14 were delivered normally. The other patient had albuminuria and was delivered of a dead child. In 44 cases after hysteropexy, only 4 had complicated labors; 8 of the 41 were delivered with forceps, 1 of which was an occipitoposterior. In all, there were 60 labors, of which 55 were normal.

As to the sixth question, the scar gave rise to no subsequent trouble in 88 per cent., stitch abscesses occurred in 7.7 per cent., and hernia followed the operation in 3.6 per cent. Both these troubles occurred with greater frequency after inflammatory diseases of the appendages. Of the clean cases, 90 to 93 per cent. had no subsequent trouble.

ECTOPIC GESTATION. (See Vol. V., p. 575.)

It is of the greatest importance that ectopic gestation should be recognized early. When its recognition can be accomplished and the patient subjected to proper treatment prior to the rupture of the sac, she will have escaped very serious and threatened danger. Crossen, in discussing conditions simulating tubal pregnancy, says the cardinal symptoms are (1) missed menstruation, (2) sudden onset of pain, (3) bloody vaginal discharge, (4) a tender mass behind the uterus, (5) slight or no fever, (6) repeated pain and enlargement of the mass without elevation of temperature. The hemorrhage may be so severe as to demand consideration. A mass may not be perceptible because the collection is fluid blood. He classifies cases simulating ectopic gestation into two groups: The first group are those in which the principal feature is a tender mass associated with some of the other symptoms of tubal pregnancy. The second group offers as the predominating symptoms sudden pain and collapse without apparent cause. To the first class belongs gonorrheal salpingitis. Conditions which may be considered as atypical cases are miscarriages with such abnormalities as associated ovarian tumor, or a broad ligament cyst; pregnancy with such abnormalities as associated hydatiform mole, hysteria, and uterine displacement, with irregular softening of the uterus, with retroflexed uterus; tumors with anomalous conditions, such as intraligamentary cyst, with intraligamentary hemorrhage,

parovarian cyst with twisted pedicle, salpingitis, an ovarian tumor with the symptoms of pregnancy.

Anomalous forms of uterine pregnancy may very readily be mistaken for ectopic gestation. A few years ago a patient in my clinic was pregnant, and from the symptoms and distress she experienced the diagnosis of ectopic gestation was made. The pregnancy was found to be in one part of a double uterus. As the distended structure did not seem sufficiently well developed to give promise of going to term, it was removed with its contents. The woman recovered and has since given birth to a child at full term.

A number of instances have been recounted in which pregnancy occurred in one horn of a normal uterus. Herman Grad, in discussing this, says, pregnancy not infrequently occurs in one side of the uterus, which makes it for a time asymmetric, but this is finally lost. In the condition described such termination does not occur. The enlargement seems like a tumor attached to the uterus and has been mistaken for ectopic gestation. Kelly describes such a case in which he opened the abdomen and closed it after having ruptured the membranes by a sound passed by the intra-uterine route. He had seen 6 such cases. Center reports a case of combined extra-uterine and intra-uterine pregnancy. The former ruptured and was removed, the latter continued until full term. Bowers, discussing uterine pregnancy with a special reference to the proper operative period after tubal rupture, asserts that early diagnosis is the greatest factor in life saving in tubal pregnancy. Sudden severe pelvic distress during the child-bearing period should always awaken the suspicion of ruptured tubal pregnancy, and the attendant should make every effort to absolutely determine the condition. Operation should be done at once if the sac is not ruptured or when the shock has not been too great. In profound shock it is better to wait until the patient reacts, but the postponement should not be beyond forty-eight hours. He thinks vaginal section bad practice unless there has been infection and drainage is required. Physiologic salt solution is of value in shock to maintain the intra-abdominal equilibrium and for its well-known physiologic effect.

STERILITY. (See Vol. V., p. 582.)

The study of the causes of barren marriages is of the utmost sociologic importance. The gynecologist should investigate not only the woman but the man prior to subjecting the former to operative procedure, for it is a reproach to the surgeon to put her to the peril and discomfort of an operation when the fault may not be hers. R. A. Gibbon, in discussing the etiology and treatment of the condition, divides the subject into primary, relative, and secondary. Primary sterility is absolute and congenital. There are cases, however, in which a woman may live with a man for years and never become pregnant, and at his death marry again and bear children, when the condition is called relative sterility. Unless there has been a microscopic examination of the semen of the first husband there should remain the doubt whether the sterility

was not due to his incompetency rather than the assumed incompatibility or relative sterility. In secondary sterility the woman has borne one or two children and fails to become pregnant again, although there is every indication of good health with both herself and her husband.

Etiology.—Sterility may result from measures which have been employed to avoid conception; after these have been continued for a time conception is unlikely to continue. Whether a woman is sterile or otherwise is generally decided in the first three years after marriage, for, according to Matthews Duncan, but 7 per cent. give birth to the first child after that time. Marriage in the very young (sixteen to nineteen years) is considered a cause, but my own experience has not so impressed me. West gave the number of unproductive marriages among his patients as an average of 1 to 8.5. Sir James Y. Simpson found in a certain district in Scotland that 1 marriage in 10 was unproductive, while Matthews Duncan found sterility in 1 in 11. The average healthy woman living all her life in wedlock should have 10 children. One sterile marriage in 10 means a loss of 1000 children in every 100 marriages. If the husband is properly virile for procreation the following conditions are necessary for fecundation: (1) Normal ovulation, (2) cohabitation, and (3) opportunity for the ovum and the spermatozoa to meet.

Apart from the age, the causes of sterility may be structural and functional.

I. Structural: (*a*) Any condition causing physical obstruction to the sexual act, as tough and unruptured hymen, vaginismus, etc.; (*b*) affections of the vagina and cervix, atresia of the vagina, vaginitis, etc.; (*c*) affections of the adnexa, and (*d*) any condition apart from the pelvic organs causing inflammation of the peritoneum, as appendicitis.

II. Functional and constitutional causes: Incompatibility, dysmenorrhea, general diseases, underfeeding, alcohol, and obesity.

The unruptured hymen may not cause sterility, for there are many cases in which pregnancy occurs and the hymen is still unruptured. A polypus or submucous fibroid is supposed to cause sterility by blocking the passage, but it is frequently due to the increased secretion, which makes the transmission of the spermatozoa through it unfavorable. The secretions may be toxic to the spermatozoa. Inflammation of the tube and especially the puerperal infections are the cause of many of the one-child cases of sterility. In some of these cases after the woman has given up hope, she becomes pregnant, which indicates that the inflammation can subside. Anything which prevents rupture of the Graafian follicles or the entrance of the ovum into the tube will cause sterility. In 332 cases of absolute sterility, which excluded women who had borne a child or had miscarried, one-half of them had spasmodic dysmenorrhea.

Sexual appetite is unnecessary to conception, but cases are noted in which a woman has lived years with a man and never became pregnant, while pregnancy occurred immediately after another marriage. Investigation disclosed that no sexual pleasure was experienced with the one, while it was marked with the other.

Tubercle, mumps, or some acute infection may cause some changes in the ovary, so that the patient does not become pregnant. Alcohol and morphin used habitually decrease the probability of pregnancy. In 215 cases of obesity Kisch found 25 per cent. of them sterile.

The woman should not be subjected to prolonged or operative treatment until the investigation of the causes of sterility are made complete by the consideration of the male. Sterility in man may be classed as follows: (1) Any condition which prevents the sexual act; (2) any condition which affects the development of the spermatozoa or interference with its fertilizing power. Psychologic conditions may render a healthy man unable to have intercourse with one woman, while they present no obstacle with another. According to Kehree, Gross, Levy, Balin, and others, 26 per cent. of all the cases of sterility in married couples are due to azoöspermia. Balin reported that in 200 men living in sterile union with wives who showed normal genital conditions, 76 had azoöspermia. As a rule this condition is a sequel of gonorrhea.

Treatment.—If there is no indication of disease in the woman, the man should be examined. All obstacles to normal coition should be removed. When there is vaginal discharge, it should be examined bacteriologically. Caruncle in women over thirty-five may be found to be a cause of vaginismus, and should be removed. When the vagina is filled with mucopus and menstruation is prolonged, the curet should be employed. It may be well to have the wife go away alone for a course of baths and medicinal waters. Ovarian and thyroid extracts are very beneficial in some instances. Hans Bab supplements them with johimbin hydrochlorid (gr. $\frac{1}{20}$ to $\frac{1}{5}$ t. i. d.).

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CHAPTER CXLIII.

SURGICAL TECHNIC.[1]

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Prevention of Wound Infection.—The sources of wound infection continue to be a subject of constant investigation and experimentation. Apparently the idea that the most common sources are the skin of the patient and the hands of the surgeon is now generally accepted, and much that has been written on technic in the past few years has dealt with the avoidance of infection from these two sources. We see little now in the journals of the sterilization of instruments and suture materials, but articles on the sterilization of the skin are more numerous than ever. Chemical sterilization has again come to the fore, and mechanical cleansing, at least to the degree formerly thought necessary, has been somewhat discontinued. Much can be said at present on both sides of this question, and I readily grant that the mechanical cleansing of the skin surrounding accidental wounds is often accomplished at the expense of further infection of the wound itself, but it is difficult to see that this is any reason for discontinuing a thorough mechanical cleansing of a field of operation when no such wound exists.

Of all the agents used in the sterilization of the patient's skin, iodin is to-day probably the most popular in the large clinics the world over. This subject has already been dealt with in several chapters of this work. (See Chapters on the Surgery of the Abdominal Wall, p. 423; Surgery of Accidents, p. 946; Fractures, p. 161.) Estes voices the pretty generally accepted idea that iodin has solved the difficulty of the sterilization of the skin surrounding accidental wounds. "Soap and water and the scrubbing brush," which were formerly thought so necessary, have undoubtedly been the means of carrying all kinds of filth into the wound from surrounding parts. Efforts, it is true, were made to prevent this by packing the wound, but such protection was often faulty. Many surgeons to-day employ no cleansing whatever, but simply paint the surrounding skin with iodin: this is certainly putting that faith in iodin which Senn had years ago when he decided that it was one of the most powerful of the antiseptic agents. In the Yearbook of Surgery, 1911, Murphy inserts the following paragraph, after a discussion of the literature dealing with the use of iodin:

"The way to obtain the best results in the management of accidental wounds is to permeate the neighboring surfaces with tincture of iodin,

[1] Supplementary to Chapter LXXII., Vol. V., p. 587.

using forceps and scissors to remove contused infected tissues and foreign bodies. Then place gutta-percha strips or raffia strips deep in the wounds for drainage. Next, make a perfect approximation of the edges of the skin down to the drain and apply a dry aseptic dressing. Wounds should never be washed for disinfection. Wet dressings—either aseptic or antiseptic—should never be used. They are really septic poultices. The dry dressings should be changed as soon as they become moist from the secretions."[1]

I can subscribe to the above sentiments excepting that when infection is present, as indicated by the local symptoms of inflammation, I believe wet aseptic dressings are of value. Nothwithstanding the confidence and enthusiasm with which iodin is used at the present time, I can still see no objection to removing the dirt around a wound by dry shaving and by the use of benzin, ether, or alcohol, provided these agents are employed in such a manner as not to enter the wound itself. Hindenberg[1] reports 2 cases of accidental wound in which iodin caused some slight gangrene, and he advises the careful protection of the wound itself when applying iodin to the surrounding skin. The improper use of strong solutions of iodin on delicate skin has also resulted in blistering in a number of cases. It has been caused by the employment of too strong solutions, by applying the solution too freely to the skin of infants and to parts of the body where the skin is extremely delicate, and, particularly, by applying it to a skin not thoroughly dry. If any water has been applied to the skin within an hour or two the iodin is much more apt to produce irritation; therefore, when using iodin, it must be seen that the skin is absolutely dry. Tinker and Prince[2] enumerate some of the fallacies regarding skin disinfection. Bovée[3] presents a study regarding the use of iodin in skin sterilization based on bacteriologic tests. In emergency work, when there is no time for a thorough preparation of the skin or where this may involve further infection of an existing wound, the use of iodin is plainly indicated and gives most satisfactory results. Although I am using it more and more in emergency work, I have not yet given up the preparation of the field of operation formerly described in cases where no wound exists and where there is plenty of time for its use (Vol. V., p. 587). The use of bichlorid solutions, however, has been largely supplanted in my own practice by the use of a 70 per cent. alcohol solution.

In the dressing of wounds already infected the use of strong antiseptics is certainly on the wane, and most surgeons are content with the removal of foreign matter, the cutting away of necrotic and bruised tissue, and the establishment of thorough drainage. I am convinced that this idea needs to be thoroughly disseminated among general practitioners, into whose hands many of these cases fall, and who place entirely too much faith in the effectiveness of certain antiseptics.

[1] Münch. med. Woch., July 5, 1910; Yearbook of Surgery, 1911, p. 74.
[2] Surg., Gyn., and Obst., June, 1911, p. 530.
[3] Amer. Jour. Obst. and Dis. Women and Children, vol. lxiv., No. 1, 1911.

Preparation of the Patient.—The proper preparation of the patient for operation consists not only in seeing that the field of operation is sterilized, that the patient's intestinal and urinary tracts are in good condition, and in the careful examination of the lungs and heart, but also in preparing the patient morally and mentally for the ordeal through which he is to pass. Crile, probably more than any other surgeon, has devoted attention to this subject, as is shown in his notable paper on "Phylogenetic Association in Relation to Certain Medical Problems."[1] I am not prepared to accept all that he says in regard to the effect on certain organs by the mental condition of the patient, but no one can read what he has written and observe his method of preparation and after-care of his patients without being impressed with the fact that a patient needs moral support and encouragement

FIG. 427.—FAULTY POSITION WITHOUT SUPPORT FOR THE BACK AND WITH THE THIGHS HYPEREXTENDED. STRAIN OF THE LUMBAR SPINE AND THE SACRO-ILIAC JOINT MUST RESULT. (Goldthwait.)

both before and after an operation, and that such support tends to improve surgical results.

The better results obtained by some surgeons over those obtained by others is not always due to greater technical skill or to the exercise of better surgical judgment in the choice of the surgical procedure best suited to the case, but is undoubtedly due to the more careful preparation of the patient, a painstaking conduct of each step of the operation, and a proper after-treatment. The use of morphin and atropin before the administration of the anesthetic is becoming more generally employed; the proper choice of an anesthetic and the employment of an experienced anesthetist, constitute, in my mind, a potent force in the reduction of fear and the prevention of shock.

Goldthwait[2] makes a plea for greater care in arranging patients on

[1] Boston Med. and Surg. Jour., Dec. 15, 1910.

[2] Jour. Amer. Med. Assoc., March 4, 1911.

the operating-table for the purpose of preventing the common post-operative weak back, and describes an apparatus for holding the patient in the lithotomy position which he asserts prevents any strain (Figs. 427–429). Rixford suggests that in operating on the pelvis of stout women with rigid abdominal walls in the Trendelenburg position a better access to the field of operation can be gained by the elevation of the shoulders on pillows and the slight flexion of the knees on the abdomen.

Sterilization of the Hands.—Alcohol is used more than ever as the final step in the sterilization of the surgeon's hands; although its bactericidal qualities may be doubted, it certainly appears to have the power to render the bacteria inert, at least for some time. Most of the Continental surgeons use a 95 per cent. alcohol solution, while American surgeons, as a rule, employ a 70 per cent. solution. I still am a firm

FIG. 428.—CORRECT POSITION, WITH LUMBAR SPINE SUPPORTED AND WITH PILLOW UNDER KNEES TO PREVENT THE HYPEREXTENSION. NO STRAIN OF THE LUMBAR SPINE OR SACRO-ILIAC JOINT CAN RESULT UNDER THESE CONDITIONS. (Goldthwait.)

believer in a prolonged scrubbing with warm water and soap prior to the use of the alcohol.

M. Marquis[1] advocates the use of alcohol alone without washing with soap and water, and says that this is of far more value than the ordinary scrubbing of the hands with soap and water followed by bichlorid solution.

It may now be said that gloves are worn universally, and at the present time the dry glove seems to be preferred to the moist. These gloves are thoroughly dried, powdered, and sterilized with the dressings. I have employed the dry gloves recently, and much prefer them; though I have at times wondered whether their dry sterilization was as reliable as the moist. The results have tended to convince me that it was. The use of long sleeves has also become more popular, and I think that it is

[1] Revue de Chir., Janvier, 1912, p. 95.

an improvement over the older method which left the forearms bare; it is easy to sterilize the sleeves and not easy to perfectly sterilize the forearm.

The Wound.—It is a satisfaction to see the general adoption of the dry method of conducting an operation, and the greater respect which is now paid to the tissues through which the wound is made. This method may be said to consist in careful hemostasis, in the careful separation or division of tissues rather than the cross-cutting or tearing of them, the thorough protection of the wound edges and surrounding parts by isolating the structures to be dealt with by properly placed dry gauze pads, and the avoidance of all unnecessary crushing or tearing of tissues.

FIG. 429.—THE RIGHT LEG CORRECTLY SUPPORTED, THE LEFT SUPPORTED BY THE ANKLE NOOSE, WHICH MUST ALLOW SAG AND JOINT STRAIN. (Goldthwait.)

One rarely sees a non-infected wound washed or douched, as was the method formerly employed to remove infective material or blood-clots, which are at present not allowed to lodge on the tissues, being carefully removed by dry sponging or with the forceps. This change in technic is well illustrated in the operation of thyroidectomy, which some years ago was usually a bloody operation, but which when properly conducted to-day is a comparatively dry one. The less common use of drainage is one of the natural results of this dry technic.

There has been little recent change in the closure of wounds, except that the layer method has become more general. Horsehair has in many clinics superseded to a great extent the use of silkworm-gut, and

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where there is little tension on the sutures it is to be preferred, as it leaves much less scar and permits of more delicate approximation of the wound edges. Its fragility also is an advantage, as it prevents too tight constriction of the skin, a potent factor in the production of skin infection.

Postoperative Treatment.—The postoperative care of the wound is thoroughly discussed by Russell S. Fowler,[1] and the after-treatment of patients by Herbert J. Paterson.[2] The practice of getting patients out of bed a day or two after serious operations has not become general, and I am inclined to believe will not. On the contrary, it is quite true that unnecessarily long confinement after operation tends to produce invalidism, and in old people especially is to be avoided.

Drainage.—Newmann[3] describes the use of raffia ribbons as drainage material, and states that this material is perfectly bland and remains in the tissues unaffected by secretions. It can be repeatedly sterilized by boiling. It has considerable capillarity, but this is not as marked as that of gauze. It is extremely cheap. The fact that the individual strands may be removed from the wound without disturbance of the remaining ones is a distinct advantage.

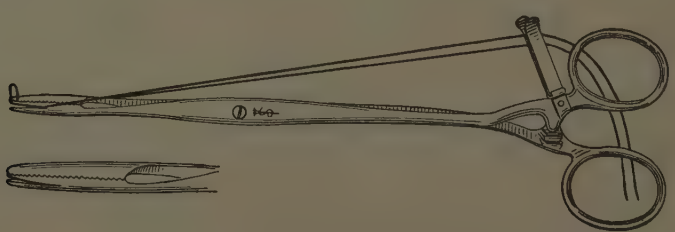

Fig. 430.—Shoemaker-Murphy Ligating Forceps.

Gutta-percha tissue, which is being used so extensively as a drainage material and as a covering for gauze drains, is discussed in a paper read by Frank before the Chicago Surgical Association.[4] One of the difficulties in connection with this material is its sterilization. Frank states, however, that this can be very simply accomplished by allowing the material to soak in a bichlorid solution of 1 : 1000 for twenty-four hours, which destroys both germs and spores. The deterioration of the gutta-percha tissue is one objection to its use, and lately at the Pennsylvania Hospital we have substituted rubber-dam as a covering for the gauze drains; this material is placed loosely about the gauze, sealed with a rubber cement, and then sterilized by heat.

Instruments and Dressings.—One often experiences difficulty in ligating vessels that have been caught by hemostatic forceps in the depth of a cavity. Fig. 430 shows a forceps which Murphy[5] has devised for this purpose.

[1] New York State Jour. of Med., Nov., 1910.
[2] The Practitioner, March, 1910.
[3] Surg., Gyn., and Obst., vol. x., 1910, p. 413.
[4] Ibid., p. 192.
[5] General Surgery, 1911, p. 46.

Russ[1] describes the use of the magnesite splint. One of the great advantages of this splint over plaster-of-Paris is that the Röntgen rays penetrate it readily. It is much denser than the plaster and yet can be readily cut with a knife having a filing edge. It is also quite elastic in thin layers, and " may be mixed with twenty times its weight of inert substance without losing its setting qualities." It is somewhat heavier than plaster, and yet, as a thinner cast may be used, this is no disadvantage.

[1] Jour. Amer. Med. Assoc., vol. l., p. 579.

CHAPTER CXLIV.

OPERATIONS ON BONES AND JOINTS.*

By James Peter Warbasse, M. D.,
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Bone-grafting and Transplantation.—Experience has added much to the operations for filling with bone wide gaps from which the bone has been removed. In cases of osteomyelitis, in which the shaft of the tibia has been destroyed, many surgeons have reported excellent results following turning a segment of the fibula into the gap. The best results have been secured by dividing the fibula at two places and fitting in a segment just the length of the tibial defect. Cases in which the fibula has been cut across at one place and bent into the gap, so as to fix the upper end of the lower fibular fragment against the upper tibial fragment, have developed an inversion of the foot which has required for its correction that the fibula be divided below and carried in to rest on top of the lower tibial segment. This shows the necessity of throwing the weight of the body upon the lower end of the tibia where it naturally belongs. In many cases it will be best to do this operation in two stages, making the upper implantation and the lower implantation several weeks or even months apart.

Rovsing,[12] in the case of a patient with osteosarcoma of the head and neck of the humerus, resected the upper two-thirds of the bone with the adjacent fascia and muscular attachments, and replaced the missing bone by the patient's fibula. The head of the fibula was articulated with the glenoid cavity, and the lower end was implanted deeply into the marrow cavity of the remaining lower third of the humerus. As a result of this operation the patient secured a movable shoulder-joint; the movements of the forearm were normal; and the strength of the leg was not materially affected (Fig. 431).

Bittner[2] resected the lower half of the shaft of the tibia for sarcoma, leaving the lower epiphysis. He filled the gap, and secured a good result, by splitting longitudinally the remaining half of the shaft up into the tuberosity, turning the segment down, and fixing it in place. Only 1.5 cm. shortening resulted, and the leg was strong and useful.

Rost[10] describes an effective operation for covering a defect of the skull by sliding over it a sufficient area of the outer table of the skull, still covered with its periosteum and scalp, the whole operation being done through parallel incisions and without pedunculating the movable flap.

* Supplementary to Chapter LXXVI., Vol. V., p. 732.

Janeway[4] removed a portion of the ulna $5\frac{1}{2}$ inches long for sarcoma, and fastened in the gap with silver wire a piece of bone of the same length, $\frac{3}{8}$ inch wide and $\frac{1}{8}$ inch thick, chiselled from the crest of the tibia with its periosteum. The result was a strong and useful arm.

Albee[1] has practised *transplantation of a portion of the tibia into the spine for the treatment of tuberculous spondylitis.* The idea is to secure

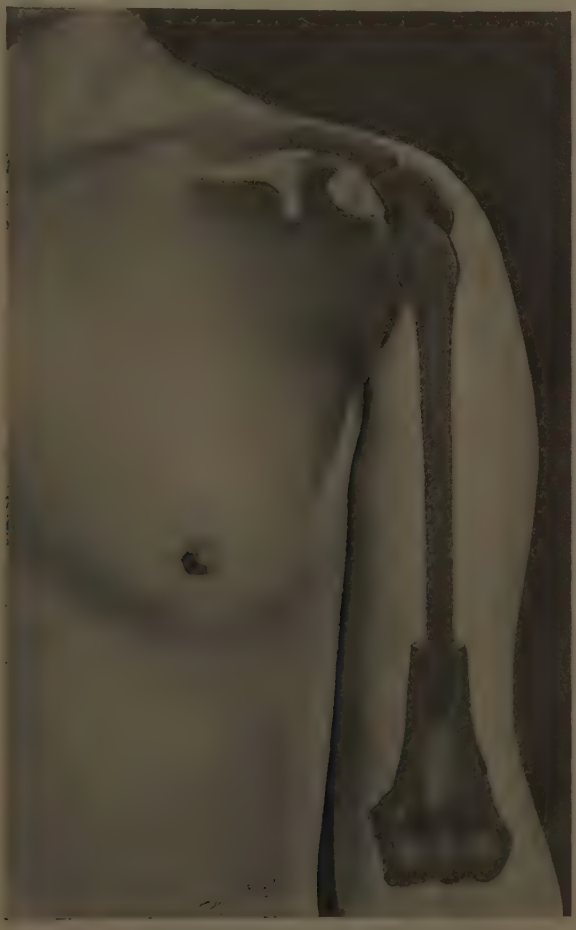

FIG. 431.—TRANSPLANTATION OF BONE.
Upper two-thirds of humerus replaced by the patient's fibula.

immobilization, which assists in the cure of tuberculosis as in other joints. When bony ankylosis in a tuberculous joint is obtained, healing usually is in sight. At first an operation was done which consisted of splitting three or four spinous processes and causing them to overlap and become united. To secure a stronger union of the vertebræ the following procedure is carried out: An incision is made directly over the tips of four spinous processes, the kyphosis being in the center. The

processes are then split longitudinally for a distance of about 1¼ inches (3 cm.) in each process. This division of the processes should be slightly to one side of the median line, so that about one-third of the process is on one side and two-thirds on the other side. The soft tissues between the processes in line with the split in the bones should be divided, and the side representing one-third of the thickness of each process fractured so as to make a wedge-shaped grove to receive the graft. The wound is then protected, and a bone-graft about 4 inches (10 cm.) long (long enough to engage all of the four spinous processes) is taken from the tibia. This represents a piece of bone about 4 inches (10 cm.) by 1 inch (2.5 cm.) by ½ inch (1.3 cm.), containing part of the internal surface, part of the external surface, and the crest. The periosteum should be retained on the graft. The wider surface should be from the internal surface of the bone. This graft is placed in the spinal gutter, and held by suturing over it the fascia by means of strong chromic catgut. The skin is then sutured and the spine immobilized by a splint.

Aseptic Bone-cavity Filling.—Next to autoplastic operations with bone, the method of cavity-filling advocated by Mosetig-Moorhof (spermaceti, 40 parts; oil of sesame, 40; iodoform, 60) has received the most approval. (See Vol. V., p. 743.)

Salt solution as a filling for bone-cavities has been used by Sherman[13] with much success. The technic is similar to that employed when other substances are used. Hemostasis is secured and the tourniquet removed. The cavity is filled with normal salt solution and the tissues snugly closed over it without drainage.

Conservative Operations for Tumors of Bone.—At present a smaller proportion of amputations and a larger proportion of conservative operations are being done for tumors of bone. An operation as radical as resection of the affected part of the bone is not called for in all cases. In giant-celled sarcoma (myeloma) one should first curet if the disease has not gone too far. There seems to be little risk of metastatis by such an operation. When curetage fails to cure myeloma, resection of the disease is called for, to be followed, if necessary, by some operation for filling the defect.

Excision of the Patella.—This operation may be done when the bone is the seat of destructive disease, when repeated fractures are associated with osteoporosis, or when the fractured patella is adherent to the femur and flexion and extension are much hampered. As much as possible of the continuation of the extensor tendon which lies in front of the bone should be preserved. This is best done by dissecting out the patella laterally through a longitudinal incision. The extensor tendon should be united to the patellar tendon. The posterior surface of the united tendon should be as smooth as possible. The best result is secured by dissecting up the synovial membrane which lies back of the extensor tendon, drawing it down behind the reconstructed tendon, and suturing it in place, with the view of covering the rough surface with synovial membrane. This latter feature of the operation is called for if the lack of relaxation does not permit direct union of the extensor tendon

with the patellar tendon, but demands the use of the prepatellar portion of the tendon to fill the gap. It is surprising how well a patient gets along without the patella. The bone is essential neither for full flexion nor extension. (Instead of removing the patella for adhesion, a better operation consists in interposing soft tissue between it and the femur to prevent ankylosis, see p. 902.)

Arthrectomy.—In the knee-joint the synovial membrane is dissected out through the **U** incision. The sac behind the quadriceps may be exposed by a longitudinal incision at one side of the patella. When disease of the bone is discovered, it is best cut away clearly with a sharp knife. The surgeon need not remove sound bone as is done in resection. Foci of disease if deep should be followed up and gouged out. The object of the operation is to remove the disease. If cavities remain, these may be filled with bone-filling preparation. Surgeons are now filling such cavities as large as a hen's egg, which a few years ago would have been treated by sawing off the whole end of the bone. By filling these cavities good results, without shortening, are secured.

In exposing the ankle-joint for tuberculosis, some surgeons prefer the anterior incision across the joint from malleolus to malleolus.

Arthrodesis.—This operation should not be done in children under eight years of age. The epiphysis should not be injured; and all the improvement and correction possible by treatment of the muscles and nerves should have been secured. So long as there is any hope of muscular recovery the operation should not be done.

The Prevention of Ankylosis by Injections of Oil.—Adhesions between the synovial surfaces in joints follow inflammatory processes. These adhesions may often be prevented by the injection into the joint of sterilized olive oil. This operation is especially indicated after the breaking up of fibrous adhesions in order to prevent their re-formation. Baer has found that joints tolerate as much oil as they will hold, and that when filled passive motion is less painful. The oil is injected with strict asepsis by means of a syringe provided with an easily separable needle. The oil should be at body-temperature and the needle should inflict the least possible trauma. This treatment is employed for the cure of various adhesive arthritides.

Rovsing[11] employs sterilized yellow vaselin. The hip-joint, he finds, holds 20 to 25 c.cm. without difficulty. The knee holds 10 to 12, at the most 15 c.cm. The shoulder holds 15 c.cm. Embolism may result if a vessel is punctured. For this reason the surgeon should be sure that the lubricant enters the joint. Rovsing employs a tube 10 cm. long, one end of which is provided with a brass ring which can be screwed on to the ordinary collapsible vaselin tube and the other end screwed into a cannula. The whole apparatus, with the vaselin tube, is sterilized by boiling. The skin is sterilized with iodin. The joint is punctured, the trocar removed, the vaselin tube connected, and the contents of the tube squeezed into the joint. The injection is not made until synovial fluid escapes from the cannula. If the synovia is turbid and has the appearance of infection, the injection is not made.

The shoulder-joint is best punctured below the hindermost corner of the acromion; the knee, by puncture outward at the upper inner angle of the patella. In the hip, Rovsing prefers to expose the capsule by an incision above the trochanter. He also exposes the jaw-joint by incision.

Operations for Ankylosis.—Operations for ankylosis due to adhesions and contractures of soft tissues need not necessarily involve the bone. Non-osseous ankylosis, which is not amenable to treatment by passive motion or oil injections, demands operation. Division or plastic elongation of tendons and muscles is often indicated. For ankylosis of the patella, a portion of the capsule above the patella can be brought down behind the bone.

Murphy[8] has shown that in ankylosis with fixation of the capsule to the head and neck of the bone, with contracture of the capsule, the capsule with the involved ligaments may be excised, and the head and neck of the bone covered with aponeurosis or muscle turned in from the neighborhood. He has shown that division of the capsule without its excision does not suffice. Motion—free from tension—must be secured, even to the point of flail motion. In the knee, when the ankylosis is due to involvement of the capsule and ligaments in inflammatory tissue, and these structures are contracted and inelastic, all of the periarticular ligaments and the capsule, excepting the hamstring tendons, the quadriceps, the patellar ligaments, and the crucial ligaments, should be dissected away.

The **interposition of periosteum for ankylosis** has been practised with much success. The bones should be separated by a chisel as near as possible to the natural line and the ends given their natural shape. Exostosis should be removed, and unhampered movement secured. A flap of periosteum of the desired size is chiselled from the tibia, care being taken to include the osteoblastic layer. Such a flap is placed over each bone-end and sutured fast. This tissue, above all others, seems best adapted to this purpose, as it is the natural barrier against osteophytic growth. With periosteum to periosteum the joint should be immobilized for three weeks or longer. Passive motion should then carefully be instituted. The results in elbow cases under this treatment have been remarkably good.

The **interposition of fascia, muscle, and connective tissue in the treatment of ankylosis** has been developed most satisfactorily by Murphy. The resisting capsule and ligaments should be removed, as described for the treatment of contractions and adhesions of the soft parts. Resisting muscles should be divided or stretched. In cases of bony ankylosis of the hip, Murphy has made a U-shaped incision embracing the great trochanter, the base of the flap being above. This flap of skin, connective tissue, and fascia lata is turned upward. The great trochanter is then divided at its base and reflected upward with its muscular connections. The capsule of the joint is then separated all the way round, and the head separated from the acetabulum by means of a curved chisel and fracturing force. Bony projections are smoothed off and the acetabulum deepened. The fascia lata in the U-shaped

flap is dissected free, fitted into the acetabulum to make a lining for it, and sutured to the capsule of the joint around the margin. The free border of the flap which projects beyond the acetabulum is sutured to the periosteum and capsule attached to the neck of the femur. The trochanter is wired in position and the wound closed. Tension is relieved by traction-extension and splints. Passive motion is attempted from the third to the fifth week. Walking with crutches is allowed about the fifth to the seventh week. Fairly free motion is secured.

FIG. 432.—SHOWING METHOD OF FIXING FASCIA BETWEEN FEMUR AND TIBIA AS DEVISED BY MURPHY.

In the knee, Murphy makes a vertical incision along the outer side of the joint, extending 6 inches above and 3 inches below the joint. A second vertical incision about 4 inches long is made on the inner side of the joint. Through these incisions the patella is freed from the femur and the ligamentum patellæ divided. The adhesions between the femur and the tibia are then divided. If contracted and adherent capsule and ligaments are present, they are removed. A flap of fascia lata, together with a layer of muscle, the base being below, is dissected from the outer surface of the vastus externus. This flap is drawn through the joint

between the two great bones and sutured to the capsule (Fig. 432). A smaller flap is cut from the fascia of the vastus and sutured in place between the patella and the femur. The joint is kept in a splint for three weeks, but passive motion and massage are applied after the first week. Forcible motion under anesthesia may be required at times. For exposure of the joint, the **U** incision, with division of the patellar ligament, may be used. Fascia may be taken both from the vastus internus and externus.

This principle has been employed by C. H. Mayo[7] in operating for bunion. After resecting the head of the metatarsal bone a soft flap is sutured in the joint, and a movable joint secured. The results reported in these cases are excellent.

In the elbow, for bony ankylosis, Murphy made a median posterior incision, and dissected free the skin and superficial fascia laterally. A pyriform flap, composed of the deep fascia lying on the triceps, $4\frac{1}{2}$ inches long and $2\frac{1}{2}$ inches wide at its upper end, was cut out. It received its blood-supply through its base, which was just below the level of the top of the olecranon. The olecranon was then sawed through obliquely from before backward with a wire saw. All of the abnormal bony connections were then divided with the chisel and exostoses removed. The flap of fascia was drawn into the joint around the inner side of the olecranon, sutured at its edges to the capsule, and the olecranon wired in place. Passive motion was begun on the tenth day.

Instead of using fascia, as was done in Murphy's earlier cases, the addition of muscular tissue or a layer of adipose tissue has decided advantages. Helferich and Reiner[9] report good results with interposed muscle in elbow resections. Deltoid muscle has been used in the shoulder-joint and pronator radii teres in the elbow. Lexer has used tunica vaginalis from hydrocele, and has suggested the employment of omentum. The anterior ligament of the elbow also lends itself for interposition. Whatever soft tissue is used, a sufficient thickness must be interposed to permit the formation of a joint sac within its structures, and this cannot take place if the tissue is thin and if it unites the two bones too intimately. (See "Arthroplasty," Vol. II., p. 370.)

Cartilage grafts in joint resections have been used by Tuffier with excellent results, In the elbow, after resection, he has applied to the fresh bone-ends tibiotarsal cartilage and cartilage from the scaphoid and astragalus. The grafts are really osteocartilaginous and are taken from freshly amputated parts.

The **interposition of foreign membranes in ankylosis** is aimed to accomplish the same results as are secured by the use of living tissue. For this purpose sterilized bladder has been used. Baer employed chromicized pig's bladder. Some good results have been secured, but not so good as have been obtained by interposing living tissue.

Exposure of the Temporomaxillary Joint by Resection of the Zygoma.—The exposure of the temporomaxillary joint has usually been accomplished by a vertical incision through the soft parts, extending from the zygoma to the facial nerve. This does not give a really free

access, and always endangers the facial nerve. Howard Lilienthal[6] has devised a temporary resection of the zygoma. He makes a horizontal incision along the zygoma, extending back to a point in front of the auricle, and thence a vertical incision is carried down in front of the ear toward the angle of the jaw. The horizontal incision passes down to the periosteum of the zygoma; the vertical incision is about 4 cm. long, and passes only through the skin, avoiding the subcutaneous structures. The triangular skin-flap is dissected free and retracted downward and

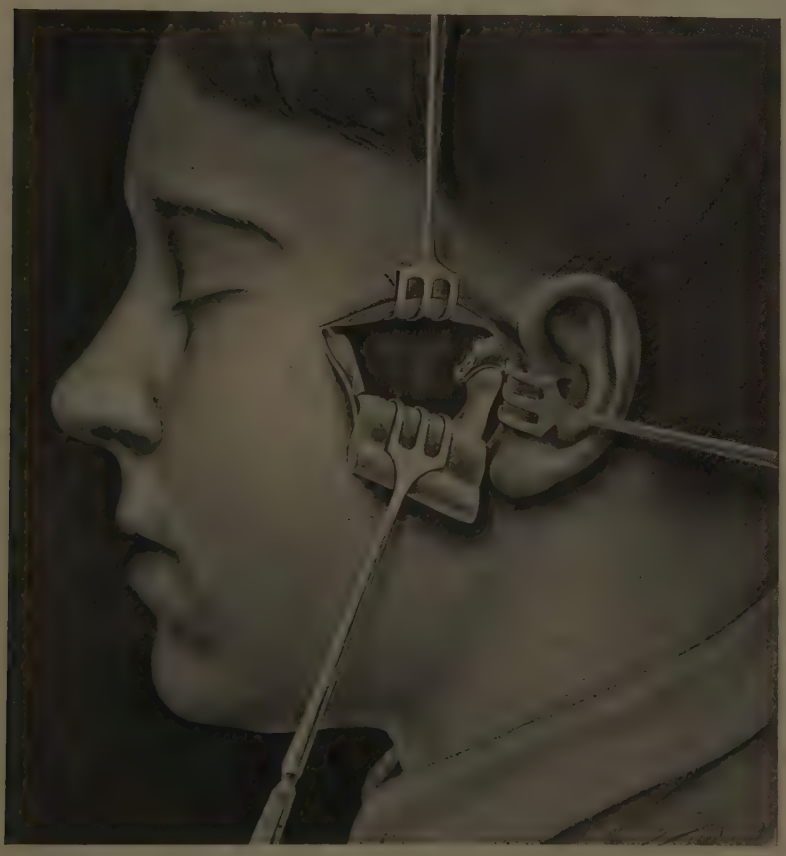

FIG. 433.—LILIENTHAL'S METHOD OF RESECTION OF ZYGOMA TO EXPOSE THE TEMPOROMAXILLARY JOINT.

forward. This exposes the zygoma. By means of the wire saw, passed under the arch, the zygoma is divided in two places, anteriorly and posteriorly. This division of the bone Lilienthal makes obliquely to the long axis of the zygoma, the anterior section passing upward and forward, and the posterior section passing upward and backward, so that when the segment is pressed back into position it cannot be drawn down by the masseter. The resected zygoma is then retracted downward, carrying with it the attachment of the masseter muscle, the upper

end of the parotid gland, fibers of the facial nerve, and connective tissue. This exposes the temporomaxillary articulation (Fig. 433).

In a case of bilateral ankylosis, Lilienthal removed the degenerated head and neck of the inferior maxilla with gouge and curet, operating first upon one side and then upon the other after an interval of nine days. Upon replacing the resected segments of zygoma, they were held firmly in place by the contraction of the masseter, and required no suture.

Artificial Filling of Joints After Resection.—The Mosetig-Moorhof spermaceti filling is often of advantage after resection of joints. If a clean operation has been done, drainage may be dispensed with and the cavity left by the removal of the bone-ends filled artificially. This method has been most successfully used in the shoulder, hip, wrist, and ankle. In the knee and smaller joints, the filling is useful for smaller cavities resulting from the cureting out of diseased foci. The filling takes the place of drainage and permits long intervals between dressings.

Transplantation of Joints.—The transplantation of soft tissues, bone, and cartilage may all be undertaken separately, or all three of these structures may be transplanted together in the form of a complete joint. The transplantation of fresh, still warm, human joints gives the best results. The material is supplied by amputations for traumatism, dry gangrene, tumors, etc. Lexer[5] has transplanted fresh human bones with their articular ends, making a graft as long as 30 cm. Single bone-ends entering into a joint may be transplanted or a whole joint may be employed. Lexer reports the transplantation of a complete knee-joint in a girl eighteen years of age. At the end of a year and a half she walked with but a slight limp and some rocking of the knee-joint. One of his cases was a man of thirty-eight years of age, in whom resection of the upper articular end of the tibia was done for sarcoma. The defect was at once filled by a similar piece from a tibia of a leg amputated for senile gangrene. In three months the patient had practically normal function. Amputated toes and fingers may be used to replace amputated members of the same kind.

The technic of these operations is most important. The strictest asepsis is essential. A slight infection spoils the result and may even jeopardize the life of the patient. The nutrition of the parts should be interfered with as little as possible. Tension should be guarded against. If suturing cannot be relied upon to hold the bones in place, pegs may be used. By shaping the bone-ends with offsets and depressions to receive them, pegs may be dispensed with. The warm bone should be transferred to its new bed as quickly as possible and without receiving any treatment excepting protection from infection. Excess of soft tissues should be removed, but the periosteum left. As the absorption of the broken-down marrow causes fever, Lexer clears it out. The cavity may be filled with the Mosetig-Moorhof bone-filling.

The Verhandlungen der Deutschen Gesellschaft für Chirurgie for 1910 and 1911 (under "Transplantation u. Plastik and Plastik u. Transplantation") are very rich in suggestions in this department of surgery.

Osteotomy Combined with Resection of Long Bones.—A section of bone is sometimes required to be removed on account of unequal length of parallel bones. This is the case when one femur is so much longer than the other that curvature of the spine is developing or an artificial lift under the foot is necessary; or in cases in which a leg bone or forearm bone outgrows its fellow and distorts the ankle or wrist. If, for example, it is desired to remove 2 inches of the shaft of the femur, longitudinal incision is made at the middle of the outer aspect of the thigh from 4 to 6 inches long, and carried down to the bone. The periosteum is elevated over 3 or 4 inches of the bone, and the overlying soft parts separated with it. Two inches are then measured off, and above and below these points the bone is drilled through for the passage of the wire to hold the divided ends. The wire saw is then passed and the bone sawed obliquely in such a way that a wedge-shaped end is secured on one fragment and a wedge-shaped indentation to receive it is secured on the other. The fragments are then dove-tailed and wired. Instead of wire or suture material for this purpose, metal plates may be screwed to the bone to hold the ends together, or a medullary plug made of the excised segment.

For Stiffening the Knee-joint.—Relaxed knee-joints, with loss of control, especially those due to infantile paralysis, have been stiffened by resection; but this has the disadvantage that it gives shortening. Hibbs[3] makes a transverse incision just below the patella, divides the patellar ligament, and turns the patella upward. The bone is then denuded of cartilage and the front of the femur and tibia similarly treated, thus making a bed to receive the patella. The crucial ligaments and the epiphyseal lines should not be harmed. The periosteum is stripped from the patella and the bone fitted into its bed. The edges of the periosteum are then laid over the freshened surfaces and sewed to the periosteum around the edges of the tibia and femur. A plaster-of-Paris splint is applied, and in four to six weeks the patient is allowed to walk. All support is removed by the end of the fifth to the seventh month. The patella becomes united to the femur and the tibia, and its stripped-off periosteum produces still more bone to solidify the union.

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CHAPTER CXLV.

AMPUTATIONS.[1]

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The chief advances which have been made of recent years in the technic of amputations have been in the direction of adapting stumps to variously devised cineplastic prostheses in the case of the upper extremities, and in the direction of producing weight-bearing stumps in the case of the lower extremities.

It is rather the exception than the rule to see an amputation, especially well done at the time of operation, leave a stump ideally fitted for its mission.

Too little attention is paid to the technic of amputations, and apparently even less care is taken now than formerly. It is likely, also, to become a question as to how much responsibility rests with the surgeon, as to whether he has done the best that could be reasonably expected of him.

The only radically new considerations in amputations concern the *stump*, as here viewed. It is not sufficient to consider only the safe removal of the limb and its subsequent uneventful healing. Much more is reasonably and rightly demanded of the surgeon, and it is likely that the day is not far distant when the question will arise as to his responsibility for the avoidable omission of technics which progressive development may prove to be the most desirable. It may suffice to simply thus allude to the tendency of the times, and to call attention to the probability that not as much advance has been made in this, one of the oldest branches of surgery, as should have been made.

The various amputations have been dealt with in detail in Vol. IV., p. 790, so that in this volume only a few salient features will be mentioned concerning some of the cineplastic and osteoplastic amputations of the upper extremities, some weight-bearing stumps of the lower extremities, the interscapulothoracic disarticulation by a posterior approach, and the interilio-abdominal disarticulation.

Cineplastic or Cinematic Amputations of the Upper Extremities.—The stump of an upper-limb amputation is satisfactory only when it can control and manipulate its artificial limb. The stump should support the artificial apparatus without discomfort and be so planned as to cause the prosthetic member to functionate. Vanghetti was the first to devise these plastic motors whose object is to functionate an

[1] Supplementary to Chapter LXXV., Vol. V., p. 790.

artificial limb, and Ceci the first to demonstrate practically the feasibility of these ideas by actual operation.

The objects sought by the technic, variously termed cineplastic, cinematic, cineprosthetic, tenoplastic, or orthopedic, are, first, to give to the artificial member, in a modified way, a voluntary and direct prehension by means of the muscular and tendinous forces which ordinarily govern its movements normally, and, second, the simplification and reinforcement of the attachment of the prosthetic member to the human body.

The principle involved is that in an amputation or a disarticulation the tendons or muscles, physiologically protected by their natural coverings, are so disposed in several different ways as to make them serve as attachments to, or bear upon, artificial members in such a way as to cause them to functionate.

The plastic motor, as the actively functionating stump is termed, is, in most of the methods, not formed of the severally separated tendons, but constitutes, in the language of Vanghetti, a " surgical individuality," consisting of muscles, tendons, sheaths, vessels, nerves, connective-tissue padding, and skin covering, all united to form a single combined active force.

Cineplastic methods, though having less range of usefulness and being less indicated, nevertheless are also applicable in the lower-extremity amputations.

If the technic and asepsis can be counted upon, cinematization ought to be completed in the single operation, otherwise, the amputation in the first operation and the cinematization in the second.

Vanghetti demonstrated that a tendon or muscle or groups of these could be isolated for several inches and their ends mobilized, and, if covered with skin and provided with nourishment, would retain their power and their voluntary contraction as well as electrical irritability. The freed muscles and tendons could be variously used, generally either as loops formed by folding backward or suturing end-to-end, or knobbed extremities simply, or reinforced by detached bone. The loops are pierced by some form of soft, unirritating tractor. The clubbed or massed ends are usually surrounded by some form of ring or collar, from which pliable tractors pass to the artificial limb.

In a general way, the loop method is indicated where there are two muscles or two muscle groups at the amputated end which can be united into a loop. The club method is indicated where the muscles and tendons are more closely intertwined.

Cineplastic amputations open a large field for surgical ingenuity, but their exact place in surgery and their full worth can only be known after a longer and wider experience than at present exists.

The previous provision of the necessary and generally complex artificial limb is to be considered.

Some of the several forms of cineplastic amputations, with different modifications of plastic motors, will be here described.

These various cineplastic methods, as I understand, have all been

used successfully in practice to a greater or less extent in human beings, and, therefore, are not only theoretic propositions.

Vanghetti's Cineplastic Amputation Through the Arm, Providing a Single Plastic Loop Motor (Figs. 434, 435).—Following amputation the musculotendinous mass of the biceps is sutured to that of the triceps, and the plastic motor thus formed is button-holed for the artificial loop or filament. As performed by Ceci, a circular incision of skin and sub-

Fig. 434.—Vanghetti's Cineplastic Amputation Through the Arm, Providing a Single Plastic Loop Motor.

cutaneous tissue is made through the arm two fingers' breadth above the fold of the elbow. The dissection of the cutaneous cuff is continued up to the union of the middle and upper thirds of the arm. The tendon of the biceps is then detached from its radial attachment, and the tendon of the triceps from its olecranon attachment. Having divided the nerves, retracted the soft parts, and formed a periosteal cuff, the bone is divided at the lower third of the arm. The tendon of the biceps is then sutured to that of the triceps, thus forming a loop, as it were, be-

yond the cut end of the bone. At a distance of 3 cm. from the free borders of the skin-cuff two opposite lateral longitudinal incisions are made 5 cm. long. The margins of these two cutaneous button-holes are now sutured together through the bicipitotricipital musculotendinous loop, after which the lower borders of the cutaneous cuff are sutured sagitally. The musculotendinous loop stump is thus entirely covered with skin and subcutaneous tissue. The button-hole is packed with gauze during the healing process and the subsequent retraction and atrophy. When the cicatrix is strong and solid, traction is exercised upon the ring. Subsequently, suitable loops are introduced through the patulous button-hole (Fig. 435), and these are conveyed down through the hollow forearm of the prosthesis and attached to the mechanism of the hand, through

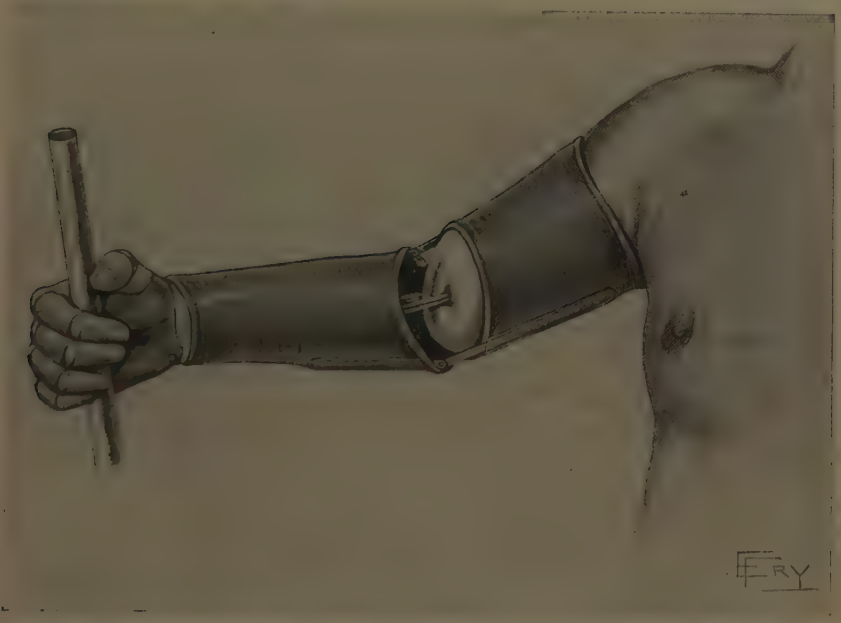
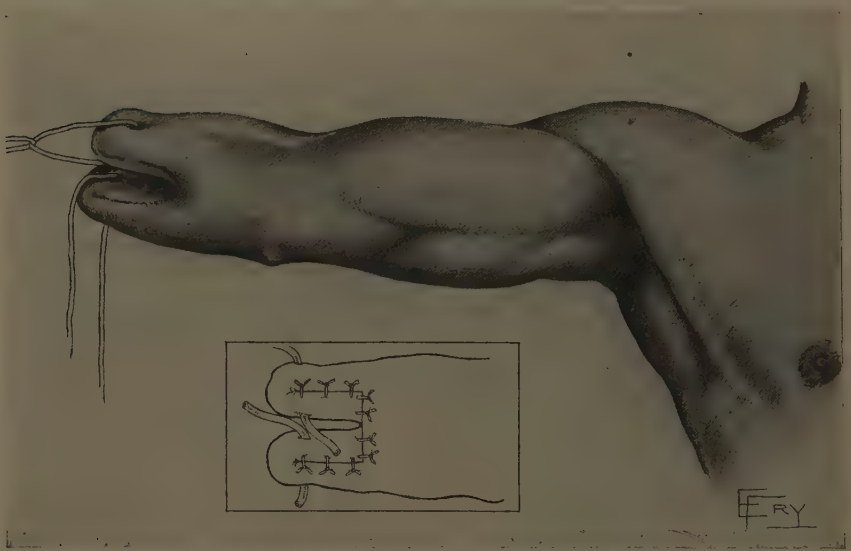


FIG. 435.—SAME AS FIG. 434, SHOWING ARTIFICIAL LIMB, WITH HAND HOLDING ROD.

which, by voluntary contraction of the stump, the fingers are flexed and objects grasped, and, through relaxation, the fingers passively opened and the object dropped (Fig. 436).

Vanghetti's Cineplastic Amputation Through the Forearm, Providing a Single Plastic Loop Motor.—The amputation here is performed through the lower part of the forearm in the general way last described, except that the motor loop is formed by suturing the tendons of the flexors to those of the extensors. A circular incision is made 1 cm. above the mediocarpal line down to the bone. Lateral longitudinal radial and ulnar incisions are made from the circular incision upward for 10 cm., down to the bone, thus forming two quadrangular musculocutaneous flaps, a posterior dorsal and an anterior ventral. The periosteum is

divided and bones sawn at the root of the flaps. The vessels are tied, the tourniquet removed, and the nerves cut. The skin of each flap is carried around its musculotendinous portion in the long axis of each flap, and sutured around it like a glove around a finger, but only for the upper two-thirds of their length, the suture of each meeting at the angle of junction of the two flaps on a level with the section of the bones. Thus the stump, at this stage, is formed of two musculotendinous columns, surrounded, in their upper part, by skin. The lower ends of these two columns are now united by suture, and the skin of each is sutured over their lower parts and together, thus completely covering them individually, but leaving a free space between them, thus forming a traction loop between the two columns of the stump formed by the



FIGS. 436, 437.—VANGHETTI'S CINEPLASTIC AMPUTATION THROUGH THE FOREARM, PROVIDING DOUBLE PLASTIC LOOP MOTORS.

The line-drawing shows the manner of suturing, and the rubber tubes temporarily distending the "button-holes."

union of the musculotendinous masses with the skin over them. The loop is packed with gauze during healing and contraction, and is subsequently used as in the last operation.

Vanghetti's Cineplastic Amputation Through the Forearm, Providing Double Plastic Loop Motors.—Two isolated musculotendinocutaneous flaps or columns are here formed, each provided with a button-hole opening, one supplying flexion, the other extension, for the prosthetic apparatus. A circular incision through skin and subcutaneous tissue is made at the lower quarter of the forearm. On a level with the line of the spontaneously retracted skin the tendons and muscles are circularly cut to the bones. Two lateral radial and ulnar incisions, 15 cm. in length, are carried to the bone. The two resulting quadrangular flaps of the skin and areolar tissue are hereby made, extending to the

upper third of the forearm. Beneath these two superficial flaps similar musculotendinous flaps are planned. At the base of these two last retracted flaps, after having provided a periosteal covering, the bones are divided. The nerves are cut short and the vessels tied. The musculotendinous dorsal flap is now divided into two approximately equal halves, especially as to the tendinous portion. The extremities of the tendons of one-half of this dorsal flap are sutured to the extremities of the tendons of the other half of the same dorsal flap in such a way as to form a dorsal musculotendinous loop. The same technic is carried out with each half of the tendons and muscles of the ventral tendinomuscular flap, thus forming a ventral musculotendinous loop (Fig. 436). The covering of these flaps with skin and the making of the two button-holes is accomplished in the following way: In each flap two longitudinal incisions are made, in button-hole fashion, each 3 cm. long, one proximal and the other distal. This last is 2 cm. from the free border of the flap,

FIG. 438.—VANGHETTI'S CINEPLASTIC AMPUTATION THROUGH THE FOREARM AS PERFORMED BY DE FRANCESCO, PROVIDING A PLASTIC CLUB MOTOR.
Splint to keep part under tension during healing and secondary contraction.

the two incisions being separated the one from the other by 2 cm. The two incisions of each flap are then put at the same level in folding back the skin flap upon the musculotendinous flap, then the borders of the space circumscribed by the two incisions (button-holes) are sutured with continuous silk. The longitudinal aspects of the flaps thus turned back are sutured. The lower borders of the sections of each flap are turned up to the level of the sawn bones of the forearm and are there sutured, as shown in the smaller line-drawing (Fig. 437). Temporary drains are used at the base of each flap to avoid tension and possible sloughing. Rubber tubing is placed through the button-holes during healing and contraction. Traction on these motor columns is practised when all is solid. The loop through the dorsal motor goes to the dorsal extensor aspect of the prosthesis, and that through the ventral motor to the flexor aspect. The patient can close the fingers, thumb, and hand by contracting the ventral motor, and open the fingers, thumb, and hand by contracting the dorsal motor.

Vanghetti's Cineplastic Amputation Through the Forearm, Providing a Plastic Club Motor.—De Francesco, in carrying out this application of Vanghetti's cinematic technic, provided for an osseomusculotendinous clubbed extremity. Following the amputation of the forearm, longitudinal incisions are made laterally over the radius and ulna, and these two bones are exposed. Through these incisions the radius and ulna are freed and removed by Gigli saw sections, over an area extending from about 2 cm. above their distal ends upward for about 5 cm. Thus approximately 2.5 cm. of each bone is removed, and nearly an inch of the distal end of each bone is left *in situ*. The terminal end of the amputation and the two lateral incisions are then sutured. During healing, in order to prevent secondary contraction, the flail portion of the forearm is kept in line and under some tension by some such method as shown in Fig. 438. When union has become solid, a padded or hard-rubber ring is applied around the knobbed stump, just above the two bony fragments, whose presence gives contour to the clubbed and enlarged extremities, over which the ring is not apt to slip when drawn upon by the two cords extending downward from opposite aspects of its circumference (Fig. 439). These cords pass to the fingers of an artificial limb, having its main support upon the arm and hinged at the elbow. Objects can be grasped by the fingers, which are voluntarily flexed by traction upon the cords, through contraction *en masse* of the flexors and extensors pulling upon the clubbed stump, and, with it, the surrounding ring, as shown in Fig. 440. The grasp is loosened by relaxation.

FIG. 439.—SAME AS FIG. 438, WITH RING AND CORDS IN POSITION, READY FOR APPLICATION OF THE ARTIFICIAL LIMB.
Showing also the two detached fragments of bone.

Vredrene's Tenoplastic Amputation Through the Forearm, Providing an Isolated Compound Tendon Loop Motor.—This application of Van-

ghetti's principle involves a laterally rather than a terminally applied tendon pull. This technic was carried out in the case of a man who had a stump from a precarpal amputation. An anterior longitudinal incision was made along the flexor aspect of the stump. Through this the superficial flexors of the forearm were exposed and were divided *en masse* at their lower part. The free tendons were then elevated in loop fashion, and their cut ends sutured to the uncut surface of the underlying

FIG. 440.—SAME AS FIG. 439, WITH PROSTHETIC APPARATUS ATTACHED TO STUMP, HOLDING GLASS OF WATER.

mass of deep flexors (Fig. 441). To cover these isolated tendons two skin-flaps were cut from the anterior aspect of the forearm, each 6 cm. long by 2 cm. wide, one above the other, upon opposite sides. These flaps were then each turned toward their pedicle and wrapped with their raw surfaces around the compound tendon loop. The two ends of the longitudinal wound are then closed, and also the margins of the sites of the skin-flaps are brought together as far as possible. In about fifteen days the base of the two flaps are severed. In about one month

from the operation traction may be applied to the loop. An artificial hand is then constructed whose fingers are flexed by the cord extending from a metal loop grasping the living loop (Fig. 442). It has been suggested that greater mobility would be secured by dividing the tendons of the flexor profundus entirely, below their artificial union with those of the flexor sublimis.

Elgart's Osteoplastic Amputation Through the Arm, Providing an Osseous Motor Capable of Transforming Lateral Rotary Movement into Flexion and Extension.—The principle demonstrated by Elgart is

FIG. 441.—VANGHETTI'S TENOPLASTIC AMPUTATION THROUGH FOREARM, PROVIDING AN ISOLATED COMPOUND TENDON-LOOP MOTOR.

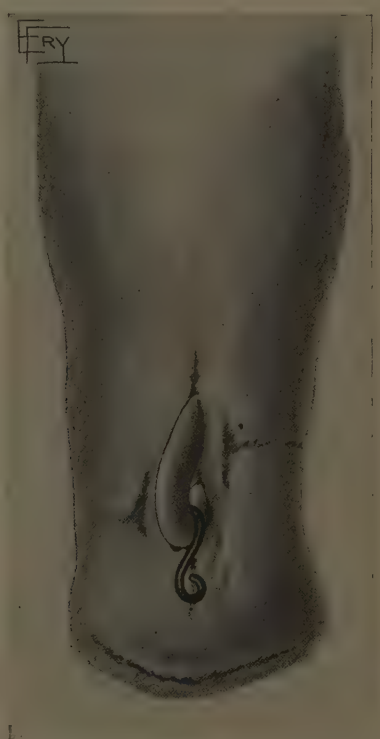


FIG. 442.—SAME AS FIG. 441: SKIN-COVERED TENDON-LOOP, WITH HARD-RUBBER RING IN POSITION, FROM WHICH LATTER CORDS PASS TO THE FINGERS OF THE ARTIFICIAL HAND.

that use should be made of all the possibilities of the stump, especially in the direction of converting movement into power, and the adaptation of the amputation method to the particular needs of the prosthetic apparatus. This would seem to be a field for much surgical ingenuity.

In stumps left after amputation through the shaft of the humerus a power is latent which has not been generally used, because it could not be gotten hold of and yoked, as it were. This is the power of rotation. The muscular force of the stump is great, and its rotation range generally averages from 90 to 120 degrees. This power must be used through mechanical means.

This object is accomplished by flattening or broadening the sawn end of the bone, so that, following healing, one can buckle on to this reorganized stump a compression cuff, so adjusted that it can neither glide upon the stump nor can the stump turn within it, but must move with every rotation of the humeral stump. From this cuff cords are conductd over small transmission wheels to the fingers of the prosthesis, as flexors and extensors of these, one cord tightening and the other relaxing simultaneously when the stump is rotated one way, and each cord doing the

FIG. 443.—ILLUSTRATING THE GENERAL PRINCIPLES OF A FORM OF PROSTHETIC APPARATUS SUGGESTED AND USED BY ELGART IN OSTEOPLASTIC AMPUTATION OF THE ARM.

Showing the splitting and the lateral divergence at the lower end of the humerus, and the overlying compression cuff or metallic shield, through which, in rotation, movement is conveyed, over transmission rollers, as finger flexion and extension, to the fingers, and, at the same time, through a different route of transmission, to the artificial elbow, as elbow flexion and extension.

opposite simultaneously when the cuff is rotated in the reverse way, thus producing either flexion or extension.

This result is brought about in the following way: A circular amputation is performed, followed by the turning up not only of the skin, but also the musculature for about 2 cm. (without raising the periosteum). Two saw cuts are carried through the bone, removing a narrow wedge, with its base at the free end and its apex at the level of the retracted soft parts. The wedge is just narrow enough to be cut. Both of the pieces of the bone to the outer sides of these cuts are broken divergingly apart with bone-forceps, carefully preserving the musculoperiosteal covering, so

that they remain still together at the apex of the wedge, but their free ends spread apart more than normal, so that the bone pieces become somewhat transverse, like two pseudocondyles. The musculature is sutured over these, and they heal in this transversely diverging relation

FIG. 444.—MARELLI'S ARTIFICIAL HAND, USED IN CONNECTION WITH PROSTHETIC APPARATUS FOLLOWING CINEPLASTIC AMPUTATIONS OF THE UPPER EXTREMITY. (From Elgart.)

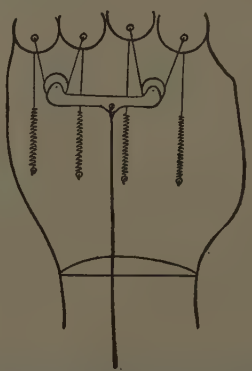


FIG. 445.—DORSAL VIEW OF MARELLI'S ARTIFICIAL HAND, SHOWING DETAILS OF EXTENSOR APPARATUS. (From Elgart.)

to the shaft of the humerus. To further strengthen the end of the new stump one can place a transplanted piece of bone in the marrow interval between the two diverging pieces of humerus.

Following healing, the padded metallic compression cuff is applied, as mentioned above and as suggested in Fig. 446. To summarize, the principle is that a lateral rotation movement, inward or outward, of the stump is converted into an axial pull and relaxation, which flexes and extends both elbow-joint and fingers.

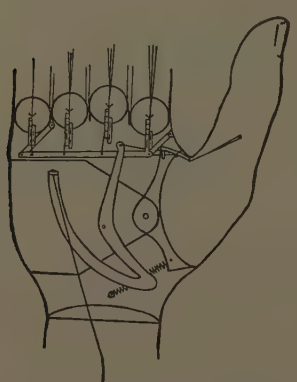


FIG. 446.—PALMAR VIEW OF MARELLI'S ARTIFICIAL HAND, SHOWING DETAILS OF FLEXOR MECHANISM. (From Elgart.)

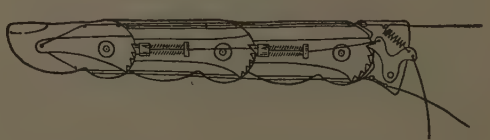


FIG. 447.—LATERAL VIEW OF THE MECHANISM OF ONE OF THE FINGERS OF MARELLI'S ARTIFICIAL HAND. (From Elgart.)

Figs. 444–447 illustrate Marelli's artificial hand, such as may be used in conjunction with an operation of this nature.

Carnes' Artificial Upper Extremity, Used in Stumps of Ordinary Type.—The credit of devising a very clever and practical form of artificial limb[1] seems justly due to Carnes, a young machinist of Warren, Pennsylvania, who, in 1902, lost his right arm by amputation two inches

[1] Made by the Carnes' Artificial Limb Co., of Kansas City, Mo.

above the elbow. Not satisfied with the best " dummy " arm he could procure, he constructed, after seven months of labor with teeth and left hand, the first form of the limb here described. In this, through the utilization of the nerve and muscle functionating of the stump and shoulder, as obtainable in the ordinary upper-extremity amputation ranging from 3 inches below the shoulder-joint to just above the wrist, he secured a limb which could be flexed and extended, with a wrist which could be rotated, and fingers which could be closed and opened. The form of this artificial limb now in use will be first described, and then its suggested adaptation to the cineplastic methods of amputation. As employed at the present time, the manipulation of the limb will be understood by the accompanying illustrations and the following description,

FIGS. 448, 449.—SHOWING THE ANTERIOR AND POSTERIOR SHOULDER STRAPS USED IN CONNECTION WITH THE CARNES' ARTIFICIAL ARM.

largely taken from the detailed account of the mechanism by the makers, and verified by myself through the working of such a limb upon an armless man. The movements are accomplished by a series of shrugs.

(1) *Elbow Movement for Above-the-elbow Amputation.*—The elbow is bent with a simple forward movement of the stump, which, by a cord attached from the forearm to the shoulder suspender, raises the hand as desired and without the assistance of the other hand.

(2) *Wrist Movement for Both Above-and-below-the-elbow Amputation.*—With the wrist unlocked one can, by an easy downward movement of the shoulder, which causes a slight tension of the cord that operates the fingers, bend the hand backward from the wrist-joint, and, by easing up on this tension, which is done by raising the shoulder slightly, drop the hand. This movement, which can be repeated at will, gives a move-

ment of the hand from the wrist-joint that is quite natural (Figs. 448, 449). The hand automatically rotates one-fourth of a circle, so that it brings a fork or spoon directly to the mouth when the hand is raised to that position. The hand can be voluntarily turned from the natural position when the arm is hanging down, to one-fourth turn when the arm is raised, and can be locked in any position between these points by a simple backward movement of the shoulder, which tightens another

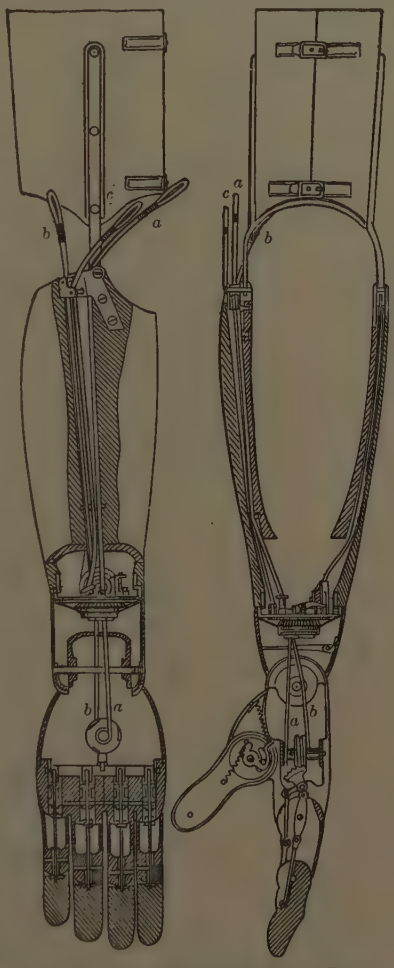
FIGS. 450–452.—THE CARNES' ARTIFICIAL ARM.

cord which locks the rotating mechanism. The wrist is provided with a hinge-joint and can be fixed or extended voluntarily, forward or backward, by means of the cord that opens or closes the fingers (Fig. 449). The rotating and flexing of the wrist is of great advantage in conveying food to the mouth while the wearer is engaged in eating, or in writing, in dressing, or in doing many of the things which require constant changes in the position of the hand, as the movements are obtained without any assistance from the sound hand whatever.

While the above movements are all made without the aid of the other hand, at the same time, through the assistance of the opposite hand, if desired, the artificial hand can be turned around to any desired position and automatically locked there, as described above. By pressing a button on the wrist the hand can be locked in any one of three positions, as, for instance, when secured at an angle of 15 degrees the hand is in a better position for writing and many other useful duties. It can also be flexed and securely locked at an angle of about 30 degrees, thus placing it in a natural position for eating, tying a cravat, and the like. The wrist will turn or remain stationary, as the wearer desires, in any of these positions. None of the positions of the hand interferes in any way with the movements of the fingers.

(3) *Finger Movement.*—The fingers are opened and closed voluntarily by a downward movement of the shoulder, which tightens a cord that reaches from the finger mechanism to the shoulder suspender. When either opened or closed, the fingers are securely locked until unlocked, which is accomplished by a simple shrug of the shoulder that slackens the cord and unlocks the mechanism, when the fingers can be operated as above described (Figs. 450–452).

(4) *For Above-the-elbow Amputations.*—The elbow is provided with a lock, so that when desired it can be locked at right angles or at other positions, and is of great advantage in carrying a coat, basket, and the like. This lock is only intended to be used for such purposes, the use of the rest of the limb being as described above.



FIGS. 453, 454.—THE MECHANICAL DETAILS OF THE CARNES' ARTIFICIAL ARM, AS NOW USED.

In the suggested adaptation of this prosthesis to cineplastic methods of amputation below the elbow, it is proposed to attach the flexor tendon loop to cord *a*, the extensor tendon loop to cord *b*, and to attach cord *c* (to lock the rotating wrist) to the front chest strap, as ordinarily used.

Carnes' Artificial Upper Extremity Proposed in Connection With Cineplastic Forms of Amputation.—The mechanical parts of the limb already in use with the ordinary stumps following amputations are shown in Figs. 453, 454. At my suggestion, these figures (453, 454) have been

drawn with a slight modification of the loops, with the purpose of adapting to this form of prosthesis the two available (flexor and extensor) tendon loops already practically secured and applied in the cineplastic method of amputation below the elbow. These drawings show the forearm and hand operated by the three cords, just as accomplished at present in ordinary amputations. The finger movements (flexion and extension) are obtained by the two cords, *a* and *b*, which are attached to the body *a*, in front of the shoulder, and *b*, back of the shoulder. These two cords are attached to the harness that loops around the opposite shoulder, similar to the one shown in the diagram of above-the-elbow harness (Figs. 453, 454). The harness for below-the-elbow amputation does away with the shoulder straps and makes the fittings more simple. The cord *c* is attached to the front of the chest. To operate the fingers, the pressure brought on cord *a* by a downward shrug of the shoulder closes the fingers, then moving the shoulder forward causes a tension on the back-strap *b*, and this opens the fingers. When the catch-button in the center of the wrist is unlocked the wrist can be moved backward and forward by a strain on the cords *a* and *b*, first upon one, and then upon the other.

To rotate the wrist the forearm is brought up as far as it will go. This causes a lever to turn a clutch around against another lever, thus pressing it down and drawing a bolt out of the opening in the plate of the wrist and unlocking the wrist. At the same time there is a spring which pushes a clutch into a notch in the bevel-gear; then, as the forearm is bent backward and forward, the wrist will rotate in unison with the same. At any time the rotation can be stopped by voluntary tension on the cord *b*, which is attached in front and across the chest, and the wrist is thereby securely locked in any desired position. All of these movements are easily obtained and without aid from the opposite hand. In suggesting the adaptation of this form of prosthesis to the cineplastic methods it is proposed to attach the flexor tendon loop to the cord *a*, and the extensor tendon loop to the cord *b*, using the cord *c* for locking the rotating wrist, as used at present (*v. s.*). If, in the future, it be found possible to isolate more tendon groups, provision for their attachment to the parts of this mechanism seems quite feasible.

Littlewood's Method of Interscapulothoracic Disarticulation by Posterior Approach.—This is a useful modification of Berger's operation, carried out by an anterior rather than a posterior approach. It is simpler than Berger's operation, the main difficulty of which lies in the ligation of the chief vessels after division of the clavicle, preliminarily to the disarticulation proper. And this holds good especially in muscular and thick-necked persons. The presence of the vein in front of the artery in the usual operation sometimes makes the ligation of the artery especially difficult, particularly when the axilla is filled by a large tumor, which destroys the normal relationships of the parts. In the posterior operation the vessels present themselves in the right order, hemorrhage is less, shock is less, and the duration of operation much shorter.

Instead of operating from in front and tying the vessels as soon as

the clavicle is divided, the operation is done from behind and the vessels divided last.

The lines of incision are those given in the ordinary operation (Vol. V., p. 834). They are also shown in Fig. 455. The operator, standing behind the patient, reflects the posterior flap sufficiently to enable the muscles inserted into the posterior border of the scapula to be exposed. These are raised upon the finger or an elevator and divided with scissors. Near the upper scapular angle the posterior scapular artery is ligated and

FIG. 455.—BERGER'S INTERSCAPULOTHORACIC AMPUTATION.
Lines of incision viewed laterally, illustrating the posterior approach.

divided. The scapula is then drawn away from the thorax by an assistant, the trapezius and omohyoid are cut, and the suprascapular vessels are tied and divided before they run into the notch. The large nerves and vessels now stand out prominently. The former are divided. The subclavian artery is then divided between two ligatures, and, at last, the subclavian vein is similarly tied and divided. The operation is completed by severing the pectoralis major and minor, the latissimus dorsi, and serratus magnus. The suturing is done in the usual way.

Osteoplastic Amputations of the Lower Extremities.—Stumps are now constructed more to withstand *direct* terminal pressure than to do so through the *lateral* pressure of a prosthetic apparatus. The stump of a lower limb is only fully successful when it is capable of bearing weight satisfactorily and without pain.

In amputations through the lower limbs, as well as in amputations in general, bone and periosteum were originally divided at one level, and no provision made for either periosteal or osseous covering for the bone-end, as shown in Fig. 456 (to the left).

Subsequently periosteal amputations were performed, a cuff or covering of periosteum being sutured over the sawn end of the bone, as shown in Fig. 457 (to the right).

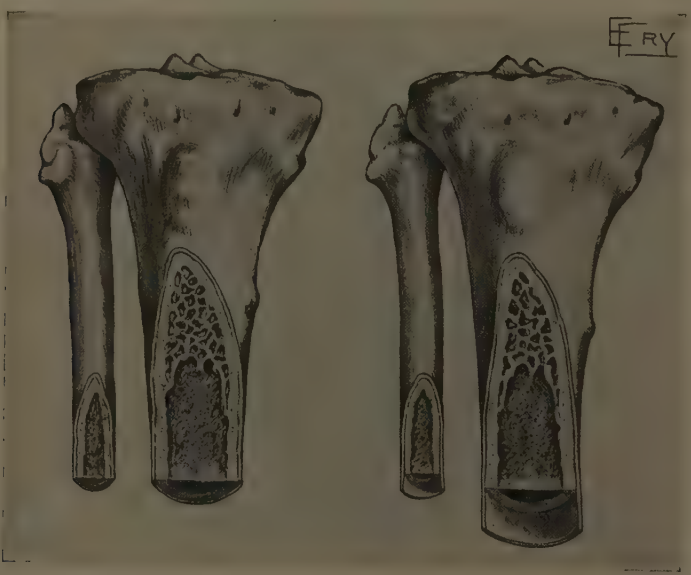


Fig. 456. Fig. 457.

Figs. 456, 457.—Old Form of Amputation.
Bone and periosteum sawn at same level (Fig. 456). Subperiosteal form of operation (Fig. 457).

Then came Bier's theory of osteoplastic amputations, upon which his method was founded, that the raw surfaces of bone are tender, and that they and the medullary canal must be covered by a flap of bone having its normal connection with the periosteum preserved, as shown in Fig. 458 (to the left).

Last of all, Bunge and Hirsch have held that Bier's views were unsound, and that it was less important to protect the sawn ends of bones from pressure than to remove all the sensitive structures at the time of operation, particularly the periosteum, and, as Bunge holds, even the marrow. Thus originated the aperiosteal type of amputating as shown in Fig. 459 (to the right), where not only the periosteum is cut shorter than the bone, but the marrow is cureted from the interior of the medullary cavity for several millimeters.

Bunge holds that the cicatricial raw ends of the bone, even with open medullary cavity, is not tender, but that tenderness is much more apt to be due to excessive growth of the periosteum and probably of the marrow, leading to exostoses, preventable by the entire removal of the terminal periosteum.

It has not been definitely proved whether the marrow is or is not sensitive.

Good results have followed all these forms of operation, but if there be complications in healing, necrosis is more apt to occur in the osteoplastic method, and exostoses in the periosteal.

The aperiosteal method is too new to have been yet thoroughly tried.

The osteoplastic technic seems the most logical, and, physiologically, the subperiosteal seems more rational than the aperiosteal.

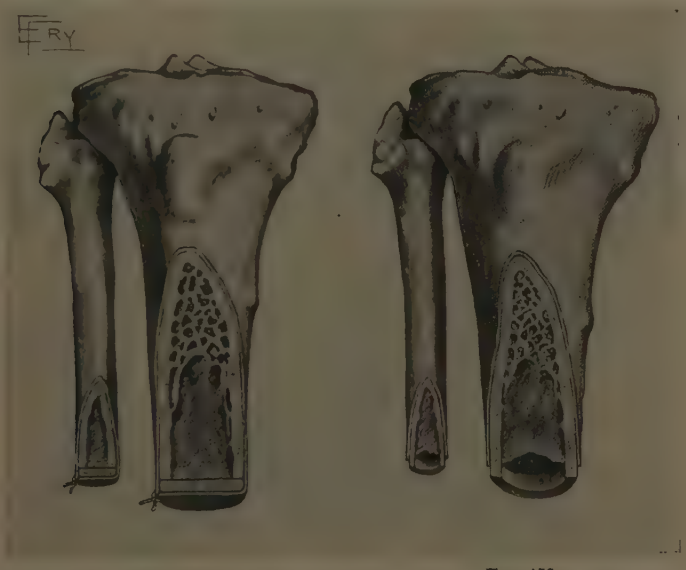


Fig. 458. Fig. 459.

Figs. 458, 459.—Bier's Osteoplastic Form of Amputation (Fig. 458). Bunge's Aperiosteal Form of Amputation (Fig. 459).

Early massaging, passive movements, and accustoming the part to bearing pressure are always indicated.

Kocher's Osteoplastic Amputation of the Leg.—Through an obliquely circular amputation an antero-internal skin-flap is dissected up, the center of the flap corresponding to the inner surface of the tibia. Divide the periosteum transversely at the level of the apex of the flap, and carry two lateral incisions upward through the periosteum 3 mm. posterior to the anterior and internal borders of the tibia. Separate the periosteum upward for a short distance and remove a small osseous wedge from the thus bared tibia. A Gigli saw is now introduced to the bottom of this wedge-shaped gap, the saw is then made to travel upward parallel with the inner surface of the tibia, separating a layer of bone correspond-

ing with the rectangular flap of periosteum. Break this bone flap across at its base by means of an elevator inserted beneath it, avoiding injury

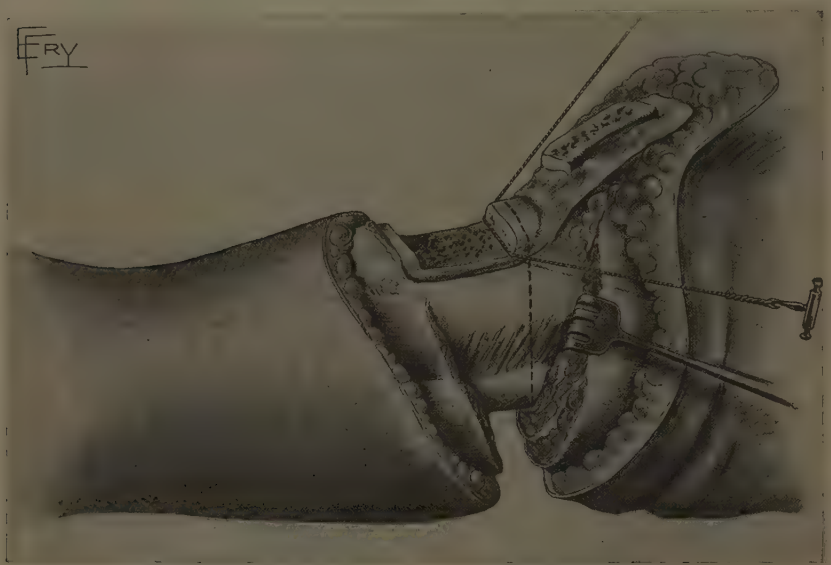


FIG. 460.—KOCHER'S OSTEOPLASTIC AMPUTATION OF THE LEG.
The manner of raising the bone-flap with the Gigli saw is shown.

to the periosteal hinge. The periosteum is then separated still slightly further upward and the soft structures are divided circularly. The

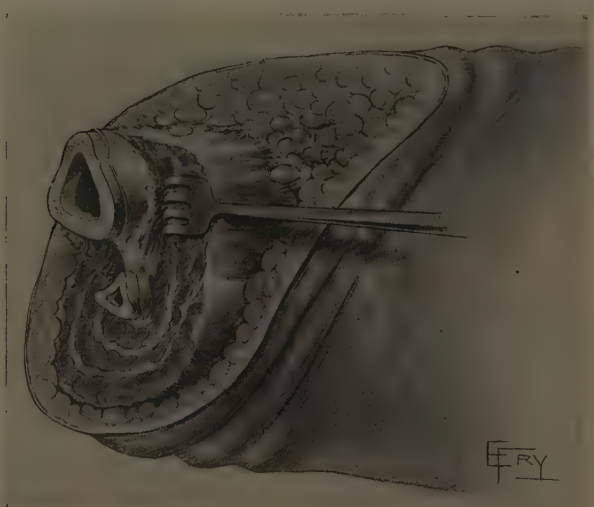


FIG. 461.—BUNGE'S APERIOSTEAL AMPUTATION OF THE LEG.
Showing the lower periosteum removed and medullary cavity cureted.

tibia and fibula are then sawn across transversely and the bony flap sutured over the divided surface of the tibia.

As suggested by Storp, the continuity of the osteoplastic flap with the skin may be secured by careful manipulation of the Gigli saw (or chisel) and careful retraction of the soft parts along the line of the saw-cut, followed by the breaking back of the flap in the manner just described. This preferable method is shown in Fig. 460. The transverse sections are made in the usual way.

The fibula should be sawn at a slightly higher level, and requires no bony flap for its protection.

FIG. 462.—INCISIONS FOR KEEN'S INTERILIO-ABDOMINAL AMPUTATION, ANTERIOR AND POSTERIOR VIEWS.

Bunge's Aperiosteal Amputation of the Leg.—The incision and exposure of the parts may be here made as in the operation last described. After firm retraction of the soft parts, the bones are transversely divided at the height selected and corresponding with the previously circularly divided periosteum. The periosteum is then again circularly divided several millimeters higher up and removed (Fig. 461). The medullary cavity is cureted to the same extent. The same procedure should be applied to the fibula, but its division should be on a slightly higher level. In closing the wound, the soft parts cover the naked bones.

Interilio-abdominal Disarticulation.—Keen's technic in this extensive operation has been described in detail in the body of the work (Vol.

V., pp. 876–878). Clearer illustrations of the lines of incision are here given (Fig. 462).

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CHAPTER CXLVI.

PLASTIC OR RECONSTRUCTIVE SURGERY.[1]

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Philadelphia.

The antiquity of reconstructive surgery seems to be established by the statement of Ehrenfried that plastic flaps are mentioned in connection with rhinoplasty in the Ebers papyrus, which is attributed to 1500 B. C.

Ingenious minds have given much expert attention to plastic reparations within the last five years. As a result, many valuable contributions to this branch of surgery have been published. This activity is seen not only in clinical reports, but also in experimental work, with its resultant opportunity for histologic and physiologic study.

Skin-grafting has been made more certain by improvements in methods, and mucous membrane grafting has apparently been used with increasing frequency. Further investigation has proved the possibility of successful transplantation of tendon and fascia and transference of muscles; and clinical applications have shown the reliability of these laboratory results in general and orthopedic surgery.

Great progress has been made in the adaptation of osteoplastic procedures to skeletal reconstructions. The development of this surgical field seems to have been slow, when the well-known reparative successes of Ollier, Macewen, and other early workers in this field are remembered. Perhaps the attention of enterprising surgeons was focused on the abdominal and cranial cavities so much that the possibilities of osteoplastic surgery escaped notice.

A study of recent literature reveals an active spirit of investigation into the question of successful grafting or transplantation of viscera. The increasing improvement in the technic of blood-vessel anastomosis, due to many investigators, and the success in experimental transplantation of kidneys by Carrel have encouraged a belief that in the future substitution of healthy viscera for diseased or injured ones may become a recognized surgical procedure.

Now that arteries and veins can be united end to end by sutures, without obstruction of the lumen, the last obstacle to successful transplantation of large blocks of tissue and of viscera has apparently been overcome. That tendons, muscles, and fasciæ would unite after section, if properly stitched, has long been an accepted truth in surgery. Later, it was established that divided nerves would regenerate and

[1] Supplementary to Chapter LXXVI., Vol. V., p. 879.

regain their functional conductivity after aseptic suturing. Success in transplanting pieces of tendon and fascia have recently been obtained, and surgeons have been shown that arteries can be patched with pieces of veins which will, under strain of the circulatory pressure, gain thickness and strength. It is, therefore, not surprising that one hears of reimplantation of a congenitally aberrant pelvic kidney to its usual

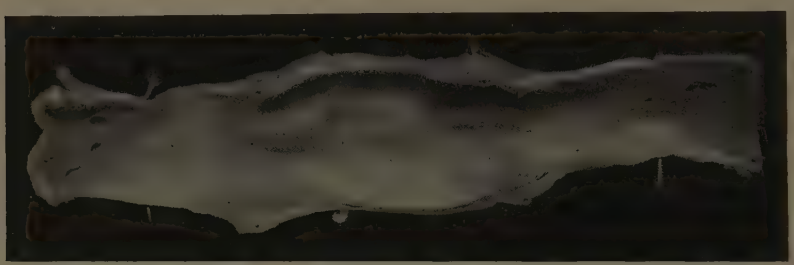

FIG. 463.—SEGMENT OF VENA CAVA TRANSPLANTED ON THE ABDOMINAL AORTA. (Carrel.) Experiment 3. Fourteen months after the operation.

lumbar location, of suggestions that portions of the body may be implanted in blocks, and of attempts such as the transplantation of the testicle of a corpse into a living scrotum which has lost this organ. The last-mentioned operation has been done by L. J. Hammond, of Philadelphia, but atrophy of the graft occurred when I examined the man. Such plastic operations are made more feasible by the evidence that aseptic grafts may be kept in cold storage for a considerable time.

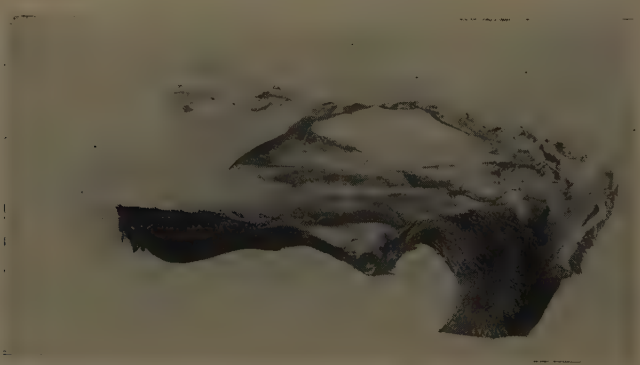

FIG. 464.—APPEARANCE OF TENDON THREE WEEKS AFTER TRANSPLANTATION. (Lewis and Davis.) The transplanted tendon is larger than the normal one on the opposite side. It is fusiform in shape and does not taper down to its insertion as the normal tendon does. The line of suture can no longer be made out. Experiment on a dog.

Intestinal substitutions and transferences furnish means of dealing with some deformities that have long baffled the surgeon. Maucaire has reported the construction of a urinary bladder, in a case of ectopia, by transferring a portion of the cecum to the suprapubic region and using the vermiform appendix for a urethra. A vagina has been made with success from a section of transferred intestine by F. T. Stewart. It is

perhaps possible that the vermiform appendix could be utilized to lengthen the urethra in hypospadias.

Ritter, desiring to use a section of small intestine for experimental plastic repair of the esophagus, has maintained the circulation of a loop, drawn outside of the body for a long time. Thus he has been able to have the graft ready for use when needed. His method is to ligate the mesenteric vessels one at a time and so to gradually give the proposed graft opportunity for vascular readjustment.

The various resections and anastomoses of the gastro-intestinal tube reported within the last two decades make operations for esophagoplasty, gastroplasty, and substitutive abdominal surgery less incredible.

Nature tolerates so many deviations from her normal standards, and so efficiently increases the strength and size of bone, muscle, fascia, and blood-vessel, when these structures are required to bear unusual stress and strain, that the possibilities of plastic or constructive surgery almost seem to be limited only by the bounds of man's ingenuity.

Carrel and Burrows have done valuable work studying the life of animal tissues outside of the body. Fragments of spleen, cartilage, thyroid gland, peritoneum, kidney, skin, and of malignant tumors were aseptically obtained from animals and placed in a plasmatic medium taken from the same animal. The material was then sealed in a hollow glass slide and kept in an incubator at 37° C. The growth of these tissues in glass was then accurately studied. Embryonal tissue and malignant tumor tissue showed a beginning growth within two or three hours; while in adult tissues the latent period before the initiation of growth was from one to three or four days. The duration of active growth was in some cases over three weeks.

Often the growth *in vitro* was very active. Under some circumstances the surface of the growth in twenty-seven hours was forty times that of the original fragment.

These studies of the laws of cellular growth have an important bearing on plastic surgery.

That periosteum taken from a cadaver days after death may be transplanted successfully to another animal of the same species and give rise to new bone is a proof of the independent vitality of animal cells. Other tissues have similar capabilities in varying degrees. Axhausen believes that the conditions are most favorable for such successful transplantation of animal tissues when the graft is taken from the individual's own body or from a near relation by blood. Hence, a younger brother or sister of the same sex as that of the patient furnishes better grafts.

Lexer has been successful in transplanting hollow viscera lined with mucous membrane. A piece of healthy vermiform appendix stripped of its serous and muscular layer has been successfully used to repair the urethra. He sewed the central end in place and drew the other end forward through the urethra. The ureter of a cadaver has also been used for this purpose.

Leriche has made an interesting study of the use of pieces of the internal saphenous vein for the plastic repair of the urethra. Attempts

have been made in this direction by himself and others. Grafts, as well as pedunculated flaps containing a segment of the vein, have been

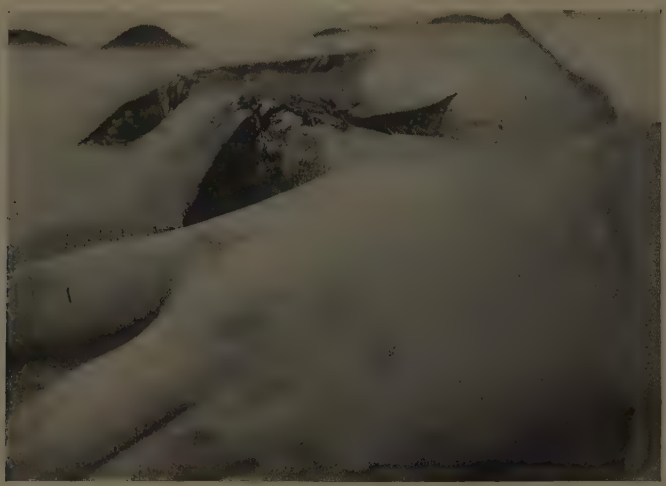

FIG. 465.—BRIDGE FLAP ON ANTEROLATERAL ASPECT OF THIGH. (Haubold.)
Thumb fastened to flap with silkworm-gut sutures.

tried. The results seem to have been encouraging rather than satisfactory.

Kuettner has transplanted with eminent success a portion of the shaft of the femur taken from a cadaver.

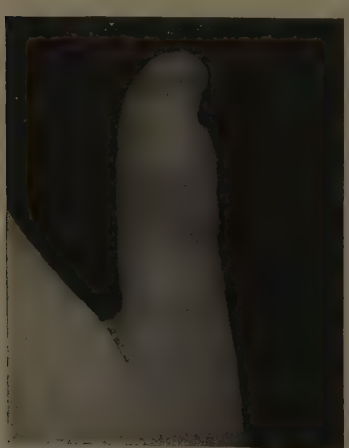

FIG. 466.—ULTIMATE RESULT ABOUT FIVE MONTHS AFTER ORIGINAL OPERATION. (Haubold.)

R. Müller has experimented on lengthening long bones. On opposite sides at a definite distance apart he saws transverse incisions extending to the midline of the bone. These are connected by a longitudinal split made with a saw in the middle line of the bony shaft. Extension then lengthens the bone until the inner corners only are in contact. The gap on each side is then filled with a block of bone sawed out of another portion of the same bone. This is similar to the well-known method of lengthening tendons.

The ovaries, the thyroid gland, and other important organs have been reimplanted, or reinforced by additions, in the human economy when their function has been destroyed or diminished. Therefore, the physiologist and surgeon are encouraged to believe that plastic substitutions may yet become available in visceral, as they now are in external or surface surgery.

Among the less dramatic, though very practical, applications of plastic surgery which are becoming frequent, are operations for removing ungainly and excessive accumulations of fat in the abdominal wall, the covering of accidentally denuded fingers and hands, or of amputation stumps with flaps of skin from the thigh or abdomen, and the early

FIG. 467.—ROBERTS' CASE OF DEEP BURN OF SACRAL REGION AND BUTTOCK, SHOWING HEALING WITH THIERSCH GRAFTS.
Grafts taken from thighs and shoulder and covered with gauze veil, sealed at borders with collodion to prevent displacement at early dressings.

treatment with skin-grafts of large ulcerated surfaces, such as occur from the sloughing of burns.

Lipectomy for pendulous abdomens from subcutaneous obesity has been advocated, particularly by Kelly. Many fingers which formerly were amputated because the integument had been stripped off by

accidental wounds may be saved by embedding the hand in a subcutaneous pouch made on the abdominal wall or the thigh. Thus the operator obtains a cutaneous covering for the damaged muscles and tendons and the broken bones. Free flaps may also be employed for this purpose.

Skin-grafting.—Until recently it was too much the custom to postpone skin-grafting of large ulcerated surfaces until they had become contracted in area and were covered with granulations containing much cicatricial fibrous tissue at their base. Aseptic skin-grafting, whether with the epidermic bits of Réverdin, the shavings of Thiersch, or the whole-thickness grafts of Wolfe, may be successfully done immediately on a recent wound or as soon as the slough separates from a burn or ulcer.

There are refinements of technic which should be carefully observed to insure success. Important details are rigid asepsis of wound and

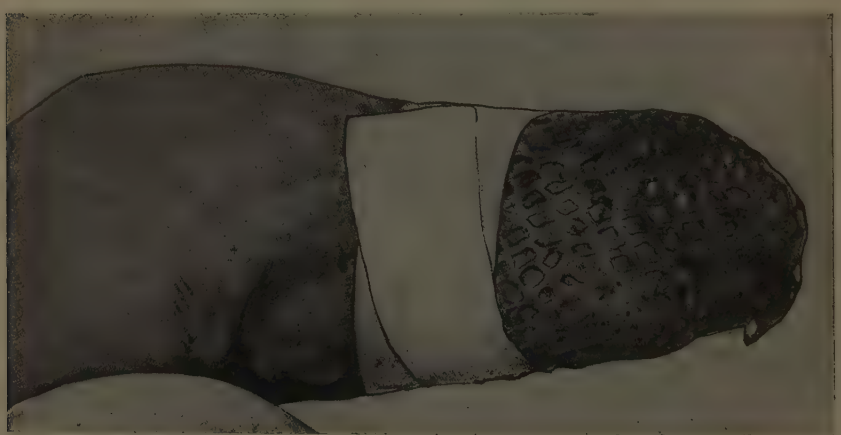

FIG. 468.—STUMP COVERED WITH WHOLE-THICKNESS GRAFTS, WHICH ARE HELD IN PLACE BY THE RUBBER IMPREGNATED MESHED MATERIAL, SECURED BY ADHESIVE STRAPS. (John Staige Davis.)

graft, close application of the graft to its new bed, free escape for air and secretions from below the graft, and such support of the parts as will prevent displacement of the graft by sliding. After the placing of epidermic grafts and skin shavings, a single layer of aseptic gauze, laid over the grafted area and fastened with collodion to the surrounding skin at a distance, will be found valuable. Over this veil the usual aseptic gauze dressing is placed, and may be changed every few days without removing the veil. The latter permits wound secretions to escape, but holds the grafts in place. A net impregnated with rubber or paraffin may be used instead of the gauze veil. Antiseptic solutions should not be allowed to touch the grafts, but suprarenal gland extract may be applied to the area to be grafted in order to arrest bleeding. The skin from which grafts are cut may be made anemic with the rubber bandage and thus furnish better whole-thickness flaps. The grafts may be taken and saved for some days in cold storage, and even when cut from a corpse

are useful. A living donor's tissue may be made anesthetic with infiltration of normal saline solution, the supplying sensory nerve may be cocainized, or the skin to be cut for grafts may be frozen with ethyl chlorid spray.

If large shavings or large whole-thickness flaps are used, they should be perforated with holes when they are pressed down on the surface which is being covered to permit escape of underlying air, and to allow wound secretions subsequently occurring to leak through and be absorbed by the aseptic dressing.

J. S. Davis speaks of the convenience of cocainizing the external cutaneous nerve when cutting grafts from the surface of the thigh. He also gives a valuable account of the histologic changes occurring in skin-grafting, and shows the method likely to secure successful transplantation of skin. His observations on successful transplanting of free flaps of fascia suggest extensions and improvements in plastic procedures.

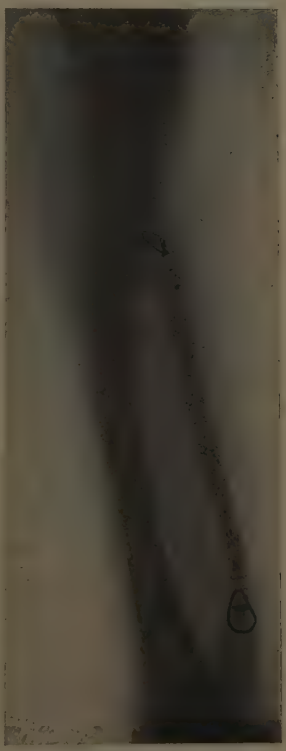

Fig. 469.—Condition of Bones Fourteen Months after Operation. (Janeway.)

Joint Transplantation. — Osteoplastic operations on joints have been stimulated by Lexer's statements relative to transplanting whole joints taken from dead bodies or previously amputated limbs. There is much encouragement in Vaughan's account of the dissection of a transplanted knee-joint eighteen months after its insertion into the leg of a man from whom a tuberculous joint was excised. He states that a process of absorption of the transplanted bone went on as the new bone was formed to take its place; and that his partial failure was largely due to the unfavorable condition of the recipient of the transplanted joint. Tomita, Grohe, Morpurgo, Läwen, Janeway, and others have contributed valuable clinical and experimental facts to osteoplastic surgery.

Esau has succeeded in constructing a fair chin in a case of undeveloped jaw following ankylosis of the temporomandibular joints in childhood. The first step was excision of the articulation and interposition of temporal fascia. Three weeks later he resected 12 cm. of the eighth rib, undermined the soft tissues of the chin, sawed through the mandible in the mental region and inserted the section of rib, which was bent to resemble the chin. The result was good. This recalls the construction of half of the horizontal ramus of the mandible by Macewen several years ago by introducing into the gap strips of rib which had been obtained by subperiosteal resection. Macewen believes that there is no special advantage in using periosteum with the bone-grafts. The value

of the periosteum as well as of the bone-marrow in osteogenesis seems, however, to be well established.

Albee has transplanted a piece of tibia to stiffen the spinal column, which was bending because of tuberculous destruction of the bodies of the vertebræ. This ingenious substitute for external support with metal braces or a cuirass of gypsum and gauze may lead to more satisfactory treatment of spinal tuberculosis.

The **implantation of a pelvic kidney** in the lumbar region by Dougal Bissell is an evidence that plastic operations of unusual interest

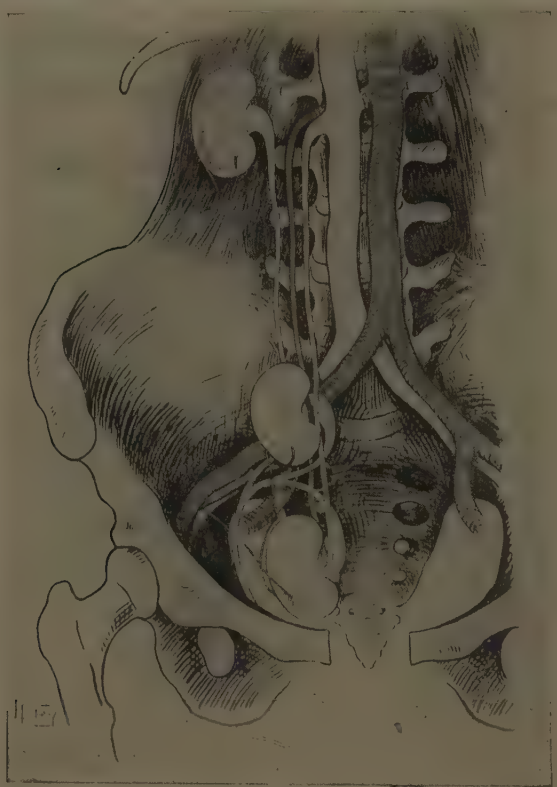

FIG. 470.—THE ABOVE IS A SCHEMATIC DRAWING. (Bissell.)
The kidney was found at the position shown in the pelvis, while the drawing at the brim of the pelvis shows the limit of elevation before the accessory arteries were severed. The kidney was anchored at the operation at the site shown in the highest drawing.

may be successfully performed on the viscera. It is not certain whether the pelvic site of the kidney was congenital or acquired.

In **rhinoplasty, otoplasty,** and other reparative operations of the face there has been great activity exhibited within a recent period. Kolle has detailed many important operations and laid special emphasis on the value of paraffin prothesis as a method for restoring contours. Roberts has laid stress on the operative treatment of facial deformities, collating the plastic methods of the general surgeon with those of the

specialists in diseases of the eye, ear, nose, and throat. H. P. Mosher and J. S. Stone have brought to the attention of surgeons many facts of value in reconstructive operations.

Lexer has also attempted to make a new nose in an ingenious manner. He saws from the anterior surface of the tibia (where it is triangular in cross-section) a piece of bone of appropriate size. This is then slipped under the skin of the arm or forearm where the hair is nearly absent, and allowed to remain there for three or four months till

FIG. 471.—THE CONTINUOUS LINE SHOWS THE INCISION FOR REMOVING THE DISEASED BREAST. THE DOTTED LINE INDICATES THE EXTENT OF THE UNDERCUTTING OF THE INTEGUMENT IN ORDER TO CLOSE THE WOUND BY DISPLACING THE SKIN. (Morestin.)

the skin and bone unite quite firmly. Then the skin and bone are to be transferred *en masse* to the site of the nose. In one patient, after apparent success, a new syphilitic ulceration destroyed the new nose. In two other cases the patients in whose arms the transplanted fragments from the tibia were about to be transplanted after three months' successful sojourn under the skin, absconded. Full details must be sought in the original papers.

The Verhandlungen der Deutschen Gesellschaft für Chirurgie for

1910 and 1911 (under "Transplantation u. Plastik and Plastik u. Transplantation") are very rich in suggestions in this department of surgery.

Morestin has proved that surgical mobilization of the integument may be accomplished in many regions to an almost incredible degree by means of extensive separation from the underlying structures. These detachments of large cutaneous areas, though formidable in appearance, are without danger, provided they be done aseptically, and that any needed drainage-tubes be slipped under the skin at proper positions to

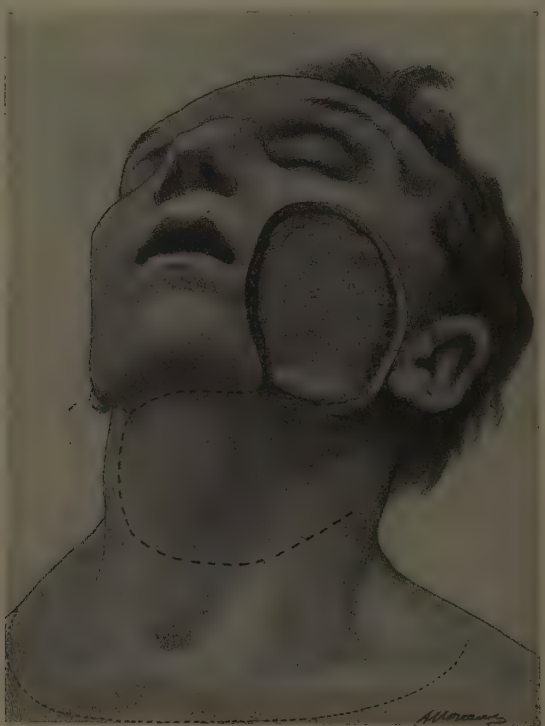

FIG. 472.—A SUPERFICIAL CANCER OF THE CHEEK HAS BEEN REMOVED. THE FLAP FROM THE FRONT OF THE NECK TO COVER THE WOUND IS SHOWN WITH A DOTTED LINE. THE SKIN TO BE UNDERMINED TO CLOSE THE GAP IN THE SURFACE OF THE NECK IS INDICATED BY A DOTTED LINE RUNNING BELOW THE CLAVICLES. (Morestin.)

carry off the fluids by gravity. The detached integuments may be displaced to a great distance from their original site, and they readily adapt themselves to new structural relations. For example, after an extensive excision of the mammary gland, flaps of skin and fascia of the neck and chest may be separated by scissors and knife from the underlying muscles and ribs, beginning at the upper part of the neck and extending as far down as the crest of the ilium. After this extensive separation, the flaps may be brought together in the mammary region so as to cover the original wound entirely. In order to permit the escape of any undue amount of blood and serum which may accumulate beneath

the large areas of transferred integument, a drainage-tube should sometimes be inserted under the edge of the flap in the neighborhood of the loin. Drainage will then occur through the action of gravity when the patient is lying in bed on her back. The regions where this extensive mobilization in reparative surgery is most easily made are the neck, the thoracic region, and the abdominal wall.

Lexer, in a communication to the German Surgical Society in April, 1911, discussed extensively the transplantation of free flaps of tissue. He suggests that such flaps will sometimes retain their vitality better if the surface upon which the grafts are to be placed is allowed to bleed until it clots. The donated tissue is then to be pressed down upon these coagula, the fibrin of which acts as an adhesive material.

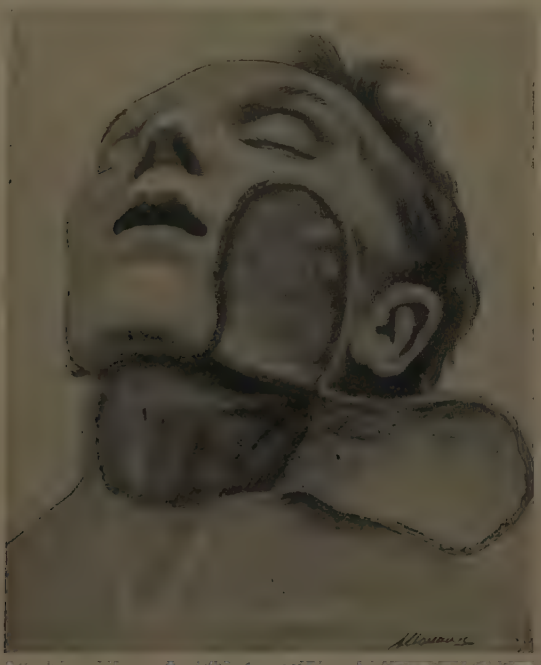

Fig. 473.—The Cervical Flap to be Used to Repair the Cheek Has Been Dissected Up. (Morestin.)

He refers to the successful use of blood-vessels and of the appendix, which should be deprived of its peritoneal surface, to reconstruct gaps in the urethra. Masses of adipose tissue may be successfully used, according to Lexer, to prevent adhesions between the dura mater and the cranium, to fill up hollows in the face, to aid in the reconstruction of joints, and as a substitute for the mammary gland, as well as to fill up eviscerated orbits. He also makes reference to the repair of defects after suppuration in the tendons of the fingers by grafts cut from the long palmar tendon. These should be inserted through small incisions made in the skin at the site of the destructive process which has caused the loss of continuity in the original tendon.

It is said that P. Magitot[1] has recently successfully transplanted a section of cornea, one-half the thickness of the cornea of an excised glaucomatous eye, into the leukomatous cornea of a patient burned with lime. The graft, it was stated, was transparent seven

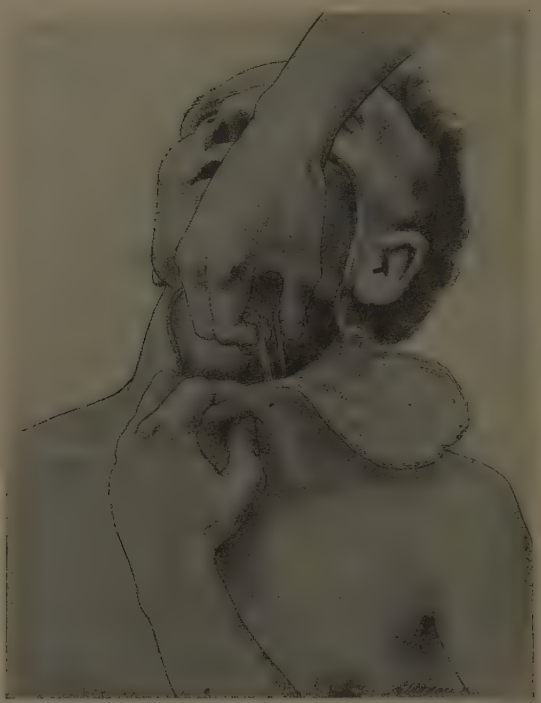

FIG. 474.—THE SKIN OF THE BASE OF THE NECK AND THE UPPER PART OF THE CHEST IS BEING UNDERMINED WITH SCISSORS, PREPARATORY TO ITS DISPLACEMENT TO CLOSE THE WOUND OF THE SURFACE OF THE NECK AFTER THE CERVICAL FLAP HAS BEEN APPLIED TO THE CHEEK. (Morestin.)

months later and afforded vision of one-tenth of the normal degree. The glaucomatous eye had been excised for pain, and was preserved in aseptic blood-serum and cold storage for eight days before use.

There have been various attempts made within recent years to restore the transparency of a cicatricial cornea by transplanting a graft of normal cornea. The method has generally been to excise the opaque leukoma with a small trephine and to insert in the opening a disk of normal and therefore transparent corneal tissue. This disk has been obtained with a trephine or punch from a recently removed human eye. The ultimate results have not been very brilliant, though a few cases have been reported in which there was some gain in vision a short time after the grafting operation.

[1] Jour. Amer. Med. Assoc., Feb. 17, 1912, p. 496, Paris letter.

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CHAPTER CXLVII.

SURGERY OF ACCIDENTS.*

By W. L. Estes, M. D.,
South Bethlehem, Pa.

During the last few years "*Conservation of the Natural Resources*" has been the slogan of the United States. The mineral, the vegetable, and the animal possessions of the country have all received consideration, and laws have been passed in every state for their care and preservation.

To thinking men the paradox of the age and the opprobrium of our nation is the curious fact that in all this talk and effort toward conservation the most valuable asset and possession of all, *human life*, has been almost entirely neglected. We sedulously protect game, we pass conservation laws for the preservation of the health and life of domestic animals, but the awful waste of human life goes on steadily and almost without restriction.

In the long list of preventable causes of death in the United States annually, 49,552 are due to violence.[9]

The Bureau of Labor states: "The normal rate of accident frequency from all causes among occupied males aged fifteen years or over in the United States is approximately 1.13 per 1000. Out of every 100 deaths from all causes among occupied males fifteen years of age or older 9.1 were deaths from accidents." [1]

The relative percentage of accidents in the various civil occupations are given[11] as follows:

Teaming	22.9	per 1000	employed.
Quarrying	15.7	"	"
Mining	14.6	"	"
Building trades	11.4	"	"
Chemical manufacturers	9.2	"	"
Electrical manufacturers	6.3	"	"
Glass industry	4.9	"	"
Printing	2.8	"	"
Average of all manufactures	9.5	"	"
Farming	11.1	"	"

The number of accidents to railroad employees, including all grades of employees, from president to brakeman, about 18 per cent. of whom are not exposed to "exceptionally fatal liability," is given as 2.19 per cent. killed and 38.94 per cent. injured.[2]

It is evident that accidents on railroads are far more frequent than in any other industry.

* Supplementary to Chapter LXXVII., Vol. V., p. 915.

The total number of accidents among the working people of the United States is so much greater than among European workers, and it is altogether so appalling in its magnitude and its continuance without any marked diminution, that sociologists are at last giving it some serious consideration, and our legislators may be induced before very long to enact statutes to protect the most valuable asset of our nation. There can be no doubt that many deaths occur from injuries on our railroads and in our industrial establishments which would not occur if these railroads and industrial establishments were required by strict laws to provide adequate and organized surgical aid for their injured people. The Red Cross Society has inaugurated a hospital car service which is to serve as a first-aid medium and for teaching.

Red Cross First-aid Car.—"The American Red Cross first-aid car is put on the road as a special Pullman car contrived as a hospital

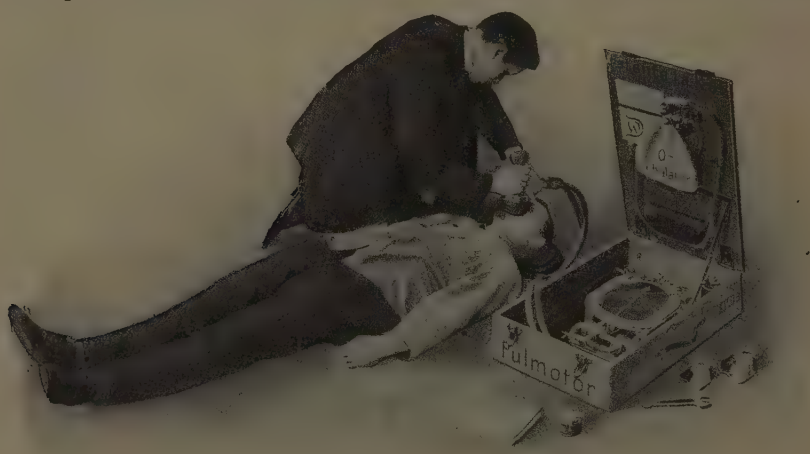

FIG. 475.—THE DRAEGER PULMOTOR OR AUTOMATIC RESUSCITATION DEVICE.

on wheels for use at disasters and as a moving lecture-room on first-aid work. Besides cooking, eating and sleeping-quarters for the staff, it has a room 26 feet long which can be used as either an emergency hospital or a lecture hall. For use at the scenes of accidents the car, as pointed out by 'The Survey,' has an equipment of scientific apparatus, such as the Draeger helmet, which is put over the head of a man entering a mine filled with poisonous gases and smoke, and the 'pulmotor,' for restoring respiration to asphyxiated persons. This apparatus* (Fig. 475) supplies oxygen to the lungs. It acts automatically and alternately by pressure and suction.† The chief purpose of the car,

* It can be obtained from the Draeger Oxygen Apparatus Co., 423 First Ave., Pittsburgh, Pa.

† The Draeger Co. has recently made and put on the market a "baby pulmotor" for the purpose of establishing breathing in cases of suspended respiration of newborn children. The principle of the apparatus is similar to that used for adults.

however, is educational—to teach the essential principles and methods of first-aid work to workmen in dangerous trades. Here it can be made the means of saving many lives. The Red Cross points out that in certain industries deaths from disease are insignificant in comparison with deaths from accident. In the registration area (comprising 55 per cent. of the country's population) accidents in 1909 caused over 67 per cent. of all deaths among steam railway employees between the ages of twenty-five and thirty-four; over 61 per cent. among miners and quarrymen, and over 28 per cent. among iron and steel workers. The accident death-rate for the workers in all mechanical and manufacturing pursuits is 21 per cent. These are the people the Red Cross is trying to reach with its first-aid car."

The tremendous expansion of the electric industry, the ever-increasing furor for rapid locomotion, introduce new dangers to the person and an ever-increasing variety of injuries.

Aëroplane Accidents.—The most recent mode of rapid locomotion —aëroplaning—can scarcely be said to introduce new varieties of wounds, but the " birdman " is subject to so many dire possibilities that, so far, comparatively few of those who have had serious accidents have lived long enough to give their surgeons a fair chance to study their cases.

Besides multiple fractures of various kinds, the birdman suffers the peril of fire from his explosive fuel (gasoline) in case of a fall. The effect of unaccustomed and rapid changes of atmospheric densities without any adequate protection in frequently and rapidly varying altitudes in his flight; successions of chilling from the cold of the upper atmosphere, variations in moisture, etc., must all have marked effect on the respiratory and circulatory systems, on the secretions and excretions, and, therefore, on the constitution of the blood. These must all modify the reaction of an aëroplanist to wounds of various kinds. Besides, the constant and great nervous tension required in his perilous flight must make big drafts on the store of nervous energy of the man who flies; keyed up to the highest pitch as he usually is, but little additional is required to disarrange the regulating fibers of his co-ordinating neurons. No doubt psychic imbalance at a critical moment serves to inaugurate the variation which results in many disasters.

Mal des Aviateurs.—Two French scientists, Cruchet and Moulinier,[4] made some interesting and important investigations of the conditions of aviators after their flights at one of the large aëroplane meets in France. After noting the tremendous psychic strain, the effect of the sudden changes of temperature and altitude on the excretory and circulatory organs, they record the fact that it is the rule that aviators upon landing complain of severe headache and an almost *uncontrollable desire to sleep*. They have grouped these several conditions and named the syndrome mal des aviateurs.

Press reports state that the American aviator, Galbraith Rodgers, explains his recent nearly fatal fall to the invincible somnolence which well-nigh overcame him at an altitude of 1000 feet, and which made him

quite unconscious by the time he had descended to 100 feet above the earth. Rodgers is reported to have said the effect was similar to that of chloroform and in no way due to atmospheric tenuosity. He attributes the fatal accidents of many aviators to this ethereal somnolence.

It would naturally follow that the first treatment of an injured birdman should be addressed especially to the psychic shock from which he would surely be suffering. It is well known that men who fall great distances always experience this form of nervous inhibition, even when they have not the mental strain of working and trying constantly to keep the equilibrium of a very unstable machine. Luckily, this psychic shock is a condition of anesthesia. The aëroplanist who falls a great distance does not feel the impact of the earth when he reaches it, usually he is killed outright, sometimes he will be dead before he reaches the earth. If he survives the instant effect of the fall and is not burned by an explosion of his gasoline fuel, first aid should begin after getting him free of the débris of his machine, with an effort to restore warmth and to administer heart stimulants. Strychnin and the vasodilators, nitrite of amyl or nitroglycerin, in my opinion, would be best.

During this stage, too, the surgeon must take measures for controling hemorrhage, though weak heart action and external vasomotor constriction allow very little loss of blood in this condition of psychic shock, even if arteries are severed. As soon as reaction begins open wounds will bleed freely, hence the importance of forestalling this. In other injuries than those of aviation I have known many instances where the patient bled to death because the physician who rendered first aid did not know or forgot that though wounds do not bleed immediately after a very severe injury, they will bleed profusely when reaction takes place.

The fractures and lacerated wounds which occur must be treated in the same way as like wounds from other sources. Improvised splints, measures to prevent further soiling of the wounds, *e. g.*, the application of clean improvised dressings and immediate transportation, if practicable, to a house or hospital where permanent dressings may be applied, should rapidly and carefully be attended to by him who renders first aid.

The Use of Iodin in Traumatic Surgery.—While iodin has been known for many years to be a most efficient germicide, its irritating qualities deterred surgeons from using it to sterilize the skin and large wounds until Grossich in 1908 published his remarkable results from its use in lacerated wounds.[5] Since then iodin, usually as the tincture or some dilution of the tincture, has been very extensively used for sterilizing the skin before operation. I have used the officinal tincture undiluted with the greatest satisfaction and with most remarkably favorable results in cases of extensive and multiple wounds, when it was impracticable, tedious, or very painful to go through the former technic for disinfecting soiled skin and badly begrimed, fresh, large lacerated wounds. The important precaution, indeed, a necessity is to remove all grease from the surface before applying the tincture of iodin, for the

iodin will not penetrate skin which is greasy. Ether or turpentine, preferably the latter, should be used when the skin is covered by the ordinary greasy grime with which the exposed skin of machinists and men working on the railroad is usually covered, to remove the grease and excess of dirt. Alcohol should next be applied to remove the turpentine and any remaining dirt, *the surface dried carefully*, then tincture of iodin applied in a thick layer over the skin about the wounds, and allowed to dry. Meantime neither gutta-percha nor rubber should be used to cover any temporary dressing, as it would probably cause very annoying irritation of the skin. After this one may undertake any operation through the skin without fear of lack of surface sterilization. For the wound itself 5 c.c. of tincture of iodin to a 1000 c.c. of hot saline solution should be used as a douche to wash out all the crevices of the laceration. Then thorough drainage should be provided, the surrounding skin carefully dried, and a masse dry dressing applied.

This technic is the best and quickest I have ever used for disinfecting extensive wounds and surrounding skin surfaces. The tincture will not irritate *unless the skin is moist* or has been made sodden by rough applications of soap and water.

It has been stated by some writers that an alcoholic solution of iodin will not penetrate deeply enough into the skin on account of the oil of the sebaceous glands. On this account many other solvents have been used experimentally, and a number of them have been recommended by various writers. Ellice McDonald[6] has recommended a solution of 2 parts iodin in 98 parts carbon tetrachlorid. Chemically this certainly is an efficient germicide, but the odor would be very objectionable; in some cases positively prohibitive.

I have found the tincture efficient and rapid for disinfecting dry surfaces of skin in emergency cases. Indeed, on skins ordinarily clean one may undertake rapid emergency operations without any other preparation than a thick coating of officinal tincture of iodin, with more confidence in the sterilization than after all the elaborate technic formerly employed. For traumatic surgery iodin is certainly the greatest boon of the last few years.

Accidents from Electricity.—It was noted in the table showing the normal accident rate in the several occupations that employees of electric manufactories showed 6.3 per 1000 employed.

New York State statistics for five years, ending with 1905, give 1923 casualties, of which 16, or 0.8 per cent., were fatal; 82.5 per cent. caused temporary disablement; and 16.8 per cent., permanent disablement.[1]

The majority of these accidents were from falls or injuries from machinery. Still a considerable number (and these are increasing with the extension of the use of high-tension currents) resulted from shocks produced by the current itself.

Stanton and Krida[12] have made some very timely studies and interesting experiments on animals. They noted in the first place that different varieties of animals react very differently to electric currents. They state: "Experimental investigations have shown beyond a doubt

that fibrillary contractions of the heart and respiratory paralysis are the chief causes of death from electric shock. And, furthermore, experimental results seem to show a fairly definite relationship between the character of the current employed and the effects produced upon the heart and the nervous system."

Direct or uninterrupted currents seem to produce somewhat different effects when the voltage is low or high. They conclude that " it seems altogether probable that ventricular fibrillations " (inco-ordinate tetanic fibrillary contraction) "may exist at least during the passage of the higher tension currents, and the failure to re-establish the normal cardiac rhythm is the cause of death in most cases."

On the nervous system, "currents of low voltage (100 volts) produce little effect except the muscular contractions at the make or break. From a clinical viewpoint the writers believe that the effect produced by the higher tension currents on the central nervous system may be regarded as a state of anesthesia quite comparable to chloroform or ether narcosis."

Alternating Currents.—The effect of alternating currents depend especially upon "the tension of the current, the frequency of the cycles, the duration of the contact, and the course of the current through the body." Their conclusions are as follows:

" 1. There are many questions concerning this subject which remain as yet unsolved.

" 2. The two great causes of death are cardiac fibrillation and respiratory paralysis.

" 3. Low-tension currents tend to kill chiefly by producing cardiac fibrillation.

" 4. As the tension is increased the effect upon the heart becomes less pronounced, but at the same time the effect upon the central nervous system becomes more and more certain as the tension is increased, so that with high-tension currents death is more likely to be caused by respiratory failure, although, if the contact is prolonged, the heart is also stopped.

" 5. We have been unable to find any reliable data concerning the action of commercial currents of more than 4500 volts, but all evidence points to the central nervous system as being the chief sufferer from the effects of currents of more than 4800 volts.

" 6. Cardiac fibrillation is fatal in spite of all known methods of treatment.

" 7. In cases of simple respiratory paralysis the patient may be kept alive by artificial respiration until the nervous system recovers from the effects of the shock.

" 8. Further investigations should be conducted to see if the method of Crile and Dolly[3] may not be combined with the high-tension contacts of Battelli[8] or those of Leduc and Robinovitch,[10] whereby resuscitation might be brought about in cases of cardiac paralysis during periods of up to five minutes following the accident."

Most of the commercial currents are high-tensioned, alternating

currents of varying frequency and large amperage. These currents, according to the foregoing, produce death by paralyzing the respiratory centers. The proper and safe thing to do is to employ artificial respiration in every case in rendering first aid. Add to this, when apparatus is available, the application of a direct current interrupted 6000 to 8000 times per minute applied through the chest, so that the current shall traverse the heart after the recommendation of Robinovitch.[10]

In hospitals Meltzer's method[7] of intratracheal pulmonary insufflation should be employed rather than ordinary methods of artificial respiration. As Robinovitch says, however, " the period of apparent death is short; four minutes . . . is a long time and five minutes is an exceedingly long period." The resuscitation must be done at the place where the shock was received to be in time to save life; this means, therefore, the employment of ordinary methods of artificial respiration.

[**Treatment for Electric Shock.**—Recently there was formed a "COMMISSION ON RESUSCITATION FROM ELECTRIC SHOCK," consisting of:

DR. W. B. CANNON, *Chairman,*
Professor of Physiology, Harvard University.

DR. GEORGE W. CRILE,
Professor of Surgery, Western Reserve University.

DR. YANDELL HENDERSON,
Professor of Physiology, Yale University.

DR. S. J. MELTZER,
Head of Department of Physiology and Pharmacology, Rockefeller Institute for Medical Research.

DR. EDW. ANTHONY SPITZKA,
Director and Professor of General Anatomy, Daniel Baugh Institute of Anatomy, Jefferson Medical College.

MR. W. C. L. EGLIN,
Past President, National Electric Light Association.

DR. A. E. KENNELLY,
Professor of Electrical Engineering, Harvard University.

DR. ELIHU THOMSON,
Electrician, General Electric Company.

MR. W. D. WEAVER, *Secretary,*
Editor, Electrical World.

They have formulated the following Rules for Resuscitation from Electric Shock. These rules have been copyrighted by the National Electric Light Association, but they generously give "permission to reprint them on application." They are, therefore, here reprinted with Dr. Estes' approval as a valuable contribution to this increasingly important subject.—W. W. Keen, editor.]

[TREATMENT FOR ELECTRIC SHOCK.

An accidental electric shock usually does not kill at once, but may only stun the victim and for a while stop his breathing.

The shock is not likely to be immediately fatal, because:

(*a*) The conductors may make only a brief and imperfect contact with the body.

(*b*) The skin, unless it is wet, offers high resistance to the current.

Hope of restoring the victim lies in prompt and continued use of artificial respiration. The reasons for this statement are:

(*a*) The body continuously depends on an exchange of air, as shown by the fact that we must breathe in and out about fifteen times a minute.

(*b*) If the body is not thus repeatedly supplied with air, suffocation occurs.

(*c*) Persons whose breathing has been stopped by electric shock have been reported restored after artificial respiration has been continued for approximately two hours.

The Schäfer, or "prone pressure" method of artificial respiration, slightly modified, is illustrated and described in the following resuscitation rules. The advantages of this method are:

(*a*) Easy performance; little muscular exertion is required.

(*b*) Larger ventilation of the lungs than by the supine method.

(*c*) Simplicity; the operator makes no complex motions and readily learns the method on first trial.

(*d*) No trouble from the tongue falling back into the air passage.

(*e*) No risk of injury to the liver or ribs if the method is executed with proper care.

Aid can be rendered best by one who has studied the rules and has learned them by practice on a volunteer subject.

Instructions for Resuscitation.

FOLLOW THESE INSTRUCTIONS EVEN IF THE VICTIM APPEARS TO BE DEAD

I. Break the Circuit Immediately

(1) With a single quick motion separate the victim from the live conductor. In so doing avoid receiving a shock yourself. Many have, by their carelessness, received injury in trying to disconnect victims of shock from live conductors.

OBSERVE THE FOLLOWING PRECAUTIONS

(*a*) Use a dry coat, a dry rope, a dry stick or board, or any other *dry non-conductor* to move either the victim or the wire, so as to break the electrical contact. Beware of using metal or any moist material. The victim's loose clothing, if dry, may be used to pull him away; do not touch the soles or heels of his shoes while he remains in contact—the nails are dangerous.

(*b*) If the body must be touched by your hands, be sure to cover them with rubber gloves, mackintosh, rubber sheeting or dry cloth; or stand on a dry board or on some other dry insulating surface. If possible, use only *one* hand.

If the victim is conducting the current to ground, and is convulsively clutching the live conductor, it may be easier to shut off the current by lifting him than by leaving him on the ground and trying to break his grasp.

(2) Open the nearest switch, if that is the quickest way to break the circuit.

(3) If necessary to cut a live wire, use an ax or a hatchet with a dry wooden handle, or properly insulated pliers.

II. Attend Instantly to the Victim's Breathing

(1) As soon as the victim is clear of the live conductor, quickly feel with your finger in his mouth and throat and remove any foreign

FIG. 475*a*.—INSPIRATION; PRESSURE OFF.

FIG. 475*b*.—EXPIRATION; PRESSURE ON.

body (tobacco, false teeth, etc.). *Then begin artificial respiration at once.* Do not stop to loosen the patient's clothing; *every moment of delay is serious.*

(2) Lay the subject on his belly, with arms extended as straight forward as possible, and with face to one side, so that the nose and mouth are free for breathing (see Fig. 475*a*). Let an assistant draw forward the subject's tongue.

If possible, avoid so laying the subject that any burned places are pressed upon. Do not permit bystanders to crowd about and shut off fresh air.

(3) Kneel straddling the subject's thighs and facing his head; rest the palms of your hands on the loins (on the muscles of the small of the back), with thumbs nearly touching each other, and with fingers spread over the lowest ribs (see Fig. 475*a*).

(4) With arms held straight, swing forward slowly, so that the weight of your body is gradually brought to bear upon the subject (see Fig. 475*b*). This operation, which should take from two to three seconds, *must not be violent*—internal organs may be injured. The lower part of the chest and also the abdomen are thus compressed, and air is forced out of the lungs.

(5) Now *immediately* swing backward so as to remove the pressure, but leave your hands in place, thus returning to the position shown in Figure 475*a*. Through their elasticity, the chest walls expand and the lungs are thus supplied with fresh air.

(6) After two seconds swing forward again. Thus repeat deliberately twelve to fifteen times a minute the double movement of compression and release—a complete respiration in four or five seconds. If a watch or a clock is not visible, follow the natural rate of your own deep breathing—swinging forward with each expiration, and backward with each inspiration.

While this is being done, an assistant should loosen any tight clothing about the subject's neck, chest, or waist.

(7) Continue artificial respiration (if necessary, two hours or longer), *without interruption*, until natural breathing is restored, or until a physician arrives. Even after natural breathing begins, carefully watch that it continues. If it stops, start artificial respiration again.

During the period of operation, keep the subject warm by applying a proper covering and by laying beside his body bottles or rubber bags filled with *warm* (not hot) water. The attention to keeping the subject warm should be given by an assistant or assistants.

(8) *Do not give any liquids whatever by mouth until the subject is fully conscious.*

First Care of Burns.

When natural respiration has been restored, burns, if serious, should be attended to until a doctor comes.

A raw or blistered surface should be protected from the air. If clothing sticks, do not peel it off—cut around it. The adherent cloth, or a dressing of cotton or other soft material applied to the burned surface, should be saturated with picric acid (0.5 per cent.). If this is not at hand, use a solution of baking soda (one teaspoonful to a pint of water), or the wound may be coated with a paste of flour and water. Or it may be protected with a heavy oil, such as machine oil, transformer oil, vaselin, linseed, Carron or olive oil. Cover the dressing with

cotton, gauze, lint, clean waste, clean handkerchiefs, or other soft cloth, held lightly in place by a bandage.

The same coverings should be lightly bandaged over a dry, charred burn, but without wetting the burned region or applying oil to it.

Do not open blisters.]

[A very large experience in burns has convinced me that the paste of flour, the oils, etc., mentioned above and as formerly advocated by myself, are not desirable means of treatment. They are never sterile and their removal afterward causes a great deal of pain. The picric acid, or, failing that, the baking soda solution, or clean vaselin from an unbroken package are the best applications, and desirable in the order named. If none of these are available, then the burns should be simply covered with clean dry cloths of some thickness until a permanent dressing can be applied in the hospital.—W. L. Estes.]

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CHAPTER CXLVIII.

NITROUS OXID ANESTHESIA.[1]

By George W. Crile, M. D.,

Cleveland, Ohio.

Nitrous oxid was introduced as an anesthetic in 1844. In 1868 Edmund Andrews, of Chicago, used a mixture of nitrous oxid and oxygen for continued anesthesia. Since then it has been in general use by dentists and occasional use by surgeons, until the recent improvements in apparatus and in technic have rapidly increased its use in general surgery.

The value of any inhalation anesthetic may be ascertained by the following tests:

As compared with ether, is it safer? Does it enable the surgeon to do his work as well? Are the technical difficulties of administration greater? Is it less disagreeable to take? Is it adapted to *long* operations? We may at once state that nitrous oxid anesthesia is technically difficult to administer, that until the surgeon has acquired an adaptation he is in certain operations somewhat hampered in his work, that nitrous oxid is a much more expensive anesthetic, that there is somewhat more venous hemorrhage. After such a statement of limitations, we may at once inquire why should nitrous oxid be used at all in general surgery. There is but a single reason, that is, it reduces not only the mortality, but minimizes suffering. If this is true, then the expense, the technical difficulties, the re-education of the surgeon have but little weight as objections, since who will compute the value of life in terms of technical difficulties or current expense. Let us inquire into the action of nitrous oxid, its relation to shock and infection, the method of administration, and the combined effect of nitrous oxid and ether, certain narcotics, and local anesthesia.

Nitrous oxid owes its anesthetic properties largely, perhaps entirely, to its diminution of the oxygen supply to the brain, or at least of the use of oxygen. The inhalation of pure nitrous oxid alone causes phenomena resembling asphyxia and speedily causes death, just as death is produced by excessive dosage of ether or chloroform. Whatever the precise chemical means by which it is accomplished, the depth of nitrous-oxid anesthesia may be wholly controlled by oxygen. Given a definite and constant in-take of nitrous oxid from an anesthetic apparatus so adjusted that by operating a valve, a stream of oxygen may be turned into the inhaled nitrous oxid gas, and the state of the patient may be altered from the slightest to the deepest anesthesia. The percentage of

[1] Supplementary to Chapter LXXX., section on Nitrous Oxid, Vol. V., p. 1034.

oxygen controls absolutely the degree of anesthesia—not only controls it, but does so most delicately. The pressure of the gas inhaled is another factor of importance. Increasing the pressure in the face-mask augments the anesthesia.

From the foregoing it is obvious that the rôle of oxygen is that of a pilot-light—just enough oxygen to keep the flame of life safely burning. Turn up this flame, the patient immediately comes out of anesthesia; turn down the flame, he is too deeply submerged; turn it out, he dies. Under a steady flow of gas under constant pressure the patient may be kept safely within the narrow zone of anesthesia. If the initial anesthesia is pushed too rapidly, stertorous deep breathing, cyanosis, muscular twitching, and even widespread muscular contractions may appear. This is faulty anesthesia.

In the Lakeside clinic our anesthetists obtain the best results by inducing anesthesia gradually.

If during the establishment of anesthesia the respiration becomes too rapid and too deep, the nitrous oxid should be at once decreased and for a minute or two ether vapor should be turned into the oxygen stream. The respiratory flurry is at once allayed; then the nitrous oxid may be again turned on.

The most important points in this anesthesia are the respiration and the color of the patient. There are numerous points in the administration of this anesthetic of interest and of importance, but mention of them here would be of little value. The skilful administration of nitrous oxid is a delicate art which can be mastered only by one possessing the power of quick and accurate observation, with the ability to make quick judgment of the state of the patient from moment to moment, and by one who has a cool head and the opportunity for constant practice.

The nitrous oxid expert develops an anesthetic intuition, and that anesthetist is the best who becomes the most delicate recording apparatus. An experience in over 4000 nitrous oxid anesthesias as a routine in a general surgical service, given by my specially trained anesthetists, has convinced me of its general application.

Without regard to the duration of the anesthesia, the patient comes out and is in full possession of all of his senses almost immediately on turning off the nitrous oxid. Hence, there may be felt the acute pain of the operation. On this account and to allay the anxiety of the patient a preliminary hypodermic injection of morphin or morphin and scopolamin is useful. This preliminary hypodermic is not given to infants, to the aged, or to those whose psychic processes are already sufficiently depressed.

Then, too, the infiltration of novocain in the line of the incision prevents the stimulation of the brain and the more completely maintains anesthetic repose.

Finally, in young, robust, and excitable patients, who may become a heavy burden upon nitrous oxid alone, a little vaporized ether is an aid. It may at once be objected that these several agencies make up a

complicated technic. This is true, but what an efficient and versatile technic? An automobile is more complicated than a cart, but it is more efficient.

This brings .us to the question of apparatus. In a large hospital the installation of a manufacturing plant reduces the cost of the gas, and by its even flow from a large gasometer facilitates administration. The type of anesthetic apparatus to be used depends much upon the individual preference. Teter has devised many useful modifications of existing machines. It is likely that some form of monovalve will prove most useful. Based on the acapnea hypothesis of Henderson, rebreathing has been employed at Johns Hopkins Hospital, but recently physiologic developments as to the rôle of acapnea has so much lessened its importance that this method may now be judged by its reducing the cost, and by the proof that rebreathing is not injurious. The warming of the gases seems a practicable aid to anesthesia and possibly affords some protection to the lungs.

After this brief description of the principles and the method of producing anesthesia, we may turn to the results accomplished. First, and perhaps the most important result accomplished, is a striking reduction in the shock of the operation. This is reduced to no less than one-third or one-fourth of that of ether. The immunity from shock is often almost incredible—apparently, the worse the risk, the better nitrous oxid acts. In the laboratory it was found that the brain cell changes on approximately equal trauma were less than one-third of those under ether. There is no special unpleasantness in taking the anesthetic. There is but trifling postoperative nausea, and but few postoperative complications of any kind. Should the occasion arise, the patient usually shows no hesitation about returning for another operation. Postoperative impairment of the vitality is much reduced, and when the new principle of anoci-association is carried out there is neither shock nor postoperative neurasthenia. In the Lakeside surgical service the following change in mortality was observed in comparing a consecutive series of ether cases with an equal series of nitrous oxid cases: In 1000 consecutive operations under ether anesthesia the surgical mortality was 4.8 per cent.; in 1000 consecutive operations under nitrous oxid anesthesia *without* anoci-association the surgical mortality was 2.7 per cent., and in 1000 consecutive operations under nitrous oxid *with* anoci-association it was 1.7 per cent.

CHAPTER CXLIX.

ANESTHESIA IN DIFFERENTIAL PRESSURE CHAMBERS, CABINETS, AND OTHER APPARATUS FOR THORACIC SURGERY.*

By Willy Meyer, M.D.,

New York.

The word "pneumothorax" was coined in 1803 by Itard,[5] a French physician. The condition it describes barred for practically a hundred years thereafter the chest cavity to the knife. The modern era of thoracic surgery dates from 1896, the year that Quénu[11] first made known the idea of restoring in pneumothorax artificially by differential air

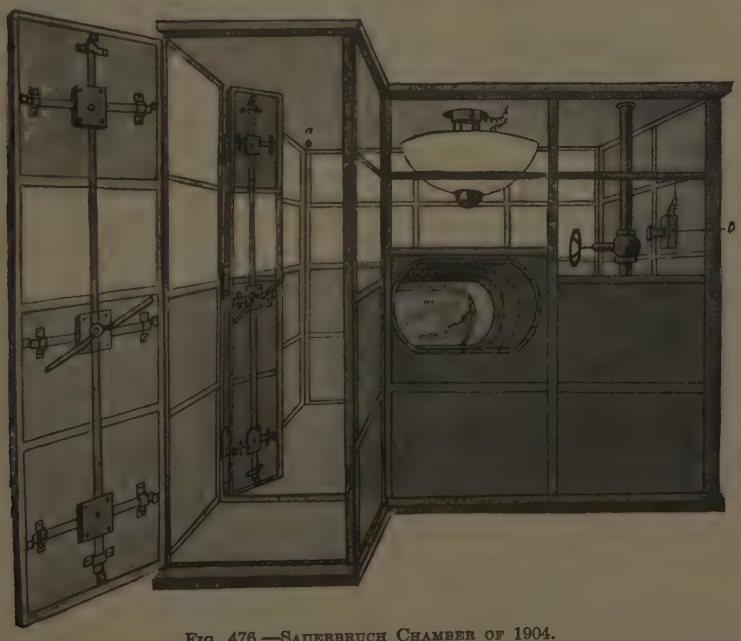

Fig. 476.—Sauerbruch Chamber of 1904.

pressure the disturbed equilibrium of the lung, and Tuffier[15] advocated the use of insufflation for the performance without pneumothorax of operations requiring the incision of the pleura. They tested their

* [See also Chapter XLI., section on Sauerbruch's Cabinet, Vol. III., p. 559; also Chapter CL., Vol. VI., p. 968, on Insufflation Anesthesia.—Ed.]

suggestions in animal experiments, which one of them, at least, followed up by operations on patients in the hospitals of Paris.

Quénu's apparatus was constructed on the lines of a diver's helmet, in which the head was placed together with a sponge saturated with chloroform. The air in the helmet was then compressed and the pleural cavity opened under atmospheric pressure. Tuffier introduced a long, narrow, slightly curved copper tube into the larynx and trachea, clamping the tissues over the tube by means of forceps, and connected the

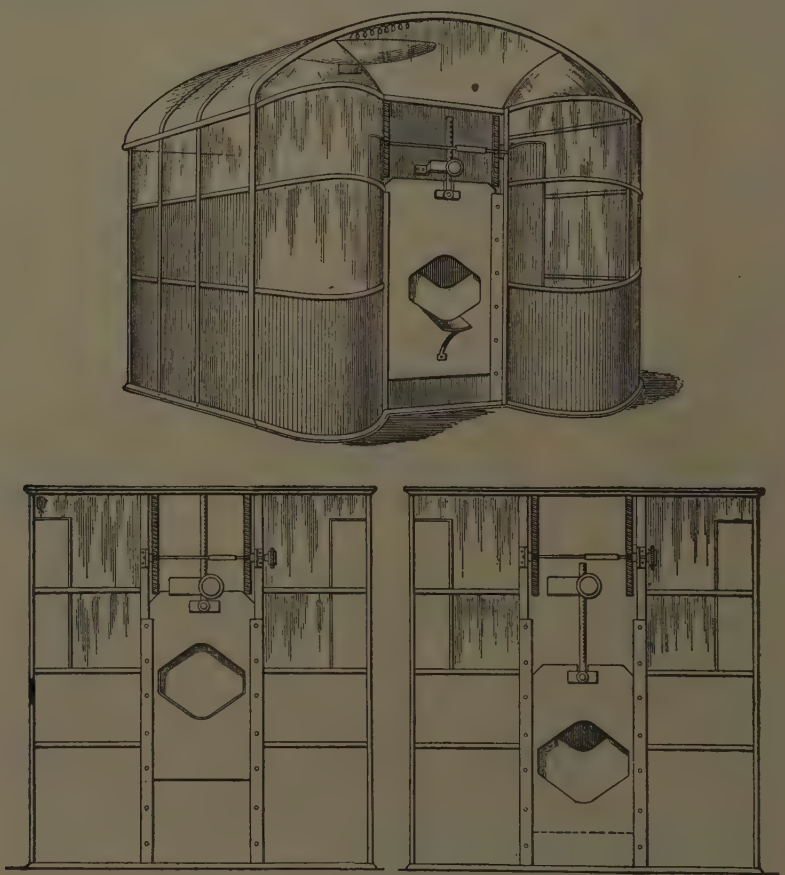

FIG. 477.—SAUERBRUCH CHAMBER OF 1910.*

free end of the tube with a bellows from which air was blown into the lung. Chloroform was administered through a fine T-tube.

At about the same time Matas,[7] of New Orleans, the first one in the United States, became interested in thoracic surgery. He constructed an apparatus of the Fell-O'Dwyer character for artificial respiration; the anesthetic was given by means of a funnel attached to a T-tube; the main tube was introduced into the larynx and the trachea. In 1898

*Built by W. Holzhauer, of Marburg, Germany.

Parham,[9] of New Orleans, made use of Matas' apparatus in performing a resection for tumor of the bony wall of the chest, the first thoracic operation of record in this country.

But all these various efforts remained isolated; they were interesting cases, and there it ended. Concerted action resulted when the differential pressure idea was conceived anew by Sauerbruch[13] in 1903. He was at the time assistant to the late Prof. von Mikulicz at the University of Breslau, Germany. The following year saw him with practical

Fig. 478.—Latest Improved Engelken Cabinet.

apparatus and tangible results. Thus, the year 1904 marks the real beginning of thoracic surgery by the transpleural route.

For its performance Sauerbruch had built at the Trelenberg Iron Works of Breslau, Germany, a chamber of about 500 cubic feet contents (Fig. 476), constructed of iron and glass, inside of which the operation is performed. Over the opened pleural cavity the air pressure is reduced below atmospheric pressure, while the patient, whose head is passed through an opening in the wall, breathes in atmospheric pressure (Figs. 477, 478).

Sauerbruch's work created a sensation in the surgical world. In

quick succession chambers were built for Berlin, Cologne, Vienna, St. Petersburg, and other places in Europe. The size of the chambers averages about 600 cubic feet; the largest one, at Vienna, contains about 750 cubic feet. Their height is usually 7 feet 6 inches.

The reverse proposition was also taken up. Sauerbruch[13] and, after him, Petersen[10] and Engelken[3] (Fig. 478), the latter two in connection with the firm of Droell, of Heidelberg, manufacturer of surgical instruments, constructed positive differential pressure cabinets, Petersen of wood and Engelken of iron and glass, boxes of about 50 cubic feet contents, into which the head of the patient is passed through an opening in the side wall. The inside air pressure is then raised above atmo-

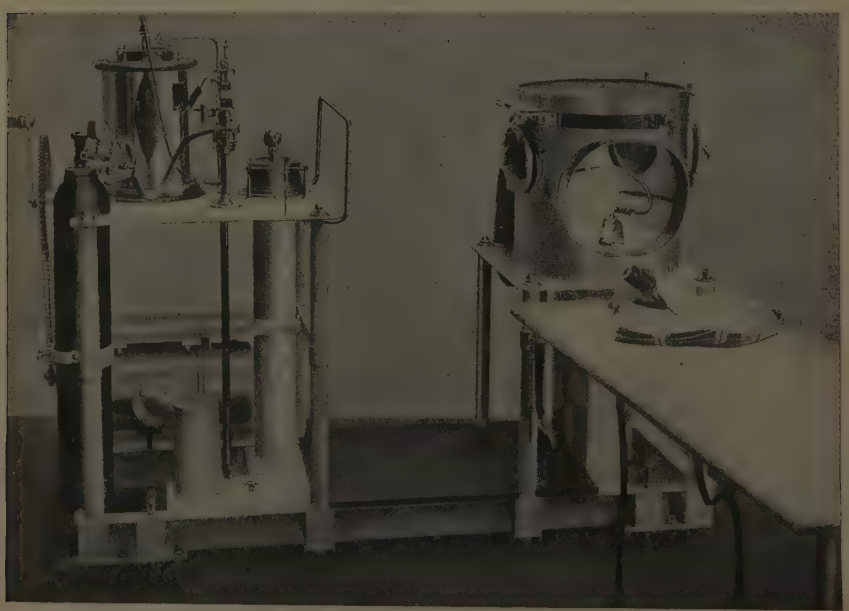

FIG. 479.—LATEST IMPROVED BRAUER. APPARATUS.

spheric pressure. The patient breathes compressed air, while outside of the cabinet the pleural cavity is opened in atmospheric pressure.

The anesthetic in operations with these chambers and cabinets is applied in the ordinary way. Sauerbruch detailed always two men to the head of his patients when operating in the negative chamber; the mentioned positive cabinets offer room for only one anesthetizer.

Sauerbruch and the other pioneers of differential pressure naturally had their whole attention riveted on this new feature. Therefore, in developing their apparatus they were quite willing to put up with inconveniences in anesthesia in order to obtain proper application of the differential pressure. Thus, in the positive pressure cabinets the narcotizer would frequently become partially narcotized with the patient; in chambers and cabinets alike surgeon and anesthetizer were separated from each other by a solid wall through which communication could be

had only by means of manual signals. The construction was such that the surgeon could not see the head of the patient, and the anesthetizer could not keep in touch with the operation or observe the patient's body. Telephones were provided; but the open air pipes connecting the pump cylinder with the chamber or the cabinet made of the latter practically a part of the pump cylinder, in which the clicking of the valves, the hissing or roaring noise of the air in the air pipes, and the boiling of the air through the water valve combined to such a noise

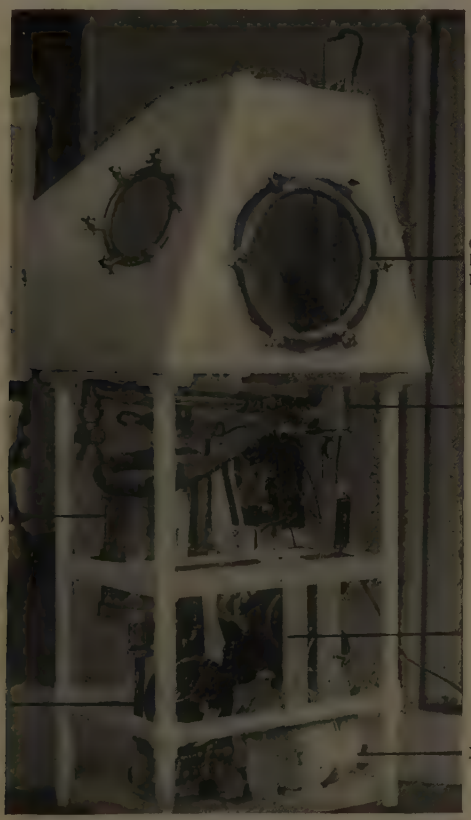

Fig. 480.—Green and Janeway's Positive Differential Pressure Apparatus—Front View.

that the telephone became inaudible. The ventilation was deficient, the air being renewed only once in ten to fifteen minutes. The anesthetizer's attention was deflected from the patient by compelling him to look after the pressure regulation and other duties, which should have been performed outside.

These inconveniences were avoided in the positive differential pressure apparatus with which Brauer[2] came forward in 1904 (Fig. 479), employing for its construction the Draeger Works, of Luebeck, Germany. The head of the patient is enclosed in an air-tight box of about 5 cubic

feet contents, in which the air is changed from four to five times every minute. The anesthetic is applied either by mask in the ordinary way, or else a Roth-Draeger drop apparatus is used in connection with an oxygen tank. Openings are provided in the side of the box through which the hands and arms of one or two anesthetizers are introduced, and made air-tight by means of rubber gloves fastened inside the box. It is thus from the outside that the anesthetizer applies the anesthetic and manipulates the head of the patient which he sees before him below a pane of glass. The bringing together of the anesthetizer and the surgeon has

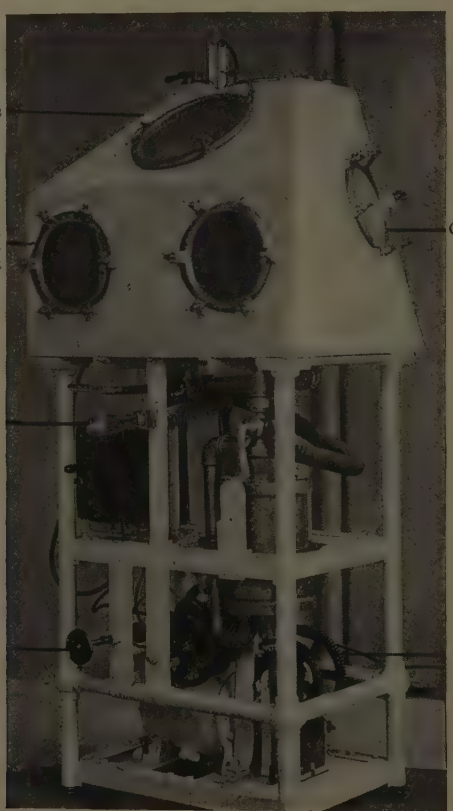

FIG. 481.—GREEN AND JANEWAY'S POSITIVE DIFFERENTIAL PRESSURE APPARATUS—BACK VIEW.

been dearly bought by the separation of the anesthetizer and the patient. In this country a positive pressure apparatus was built by Green and Janeway,[4] of New York City, in 1907, of the Brauer type, but modified and improved as to valve action and mechanical appliances for artificial respiration during anesthesia (Figs. 480, 481).

The shrinking process of the enclosed space surrounding parts of the patient, from 600 to 50 cubic feet and from 50 to 5 cubic feet, was soon carried to its logical conclusion in apparatus which dispenses with it altogether. Its place is taken by mask and intubation tubes. Of the

mask type are the apparatus of Brat-Schmieden[1] (Fig. 482), built by the Oxygenia Co., Berlin, manufacturers of life-saving appliances for mines, and of Tiegel[14] (Figs. 483, 484), built by Georg Haertel, Breslau, manufacturer of surgical appliances. In both the drop method of administering the anesthetic is used in combination with an oxygen tank, the oxygen stream carrying the anesthetic to the lung. The pressure in the lung is maintained by expiration against either a spring valve (Schmieden) or a water column (Tiegel). Of the intubation type is the apparatus of Kuhn[6]; a tube as large as the larynx will admit is introduced into the

Fig. 482.—Brat-Schmieden Apparatus.

trachea and compressed air mixed with ether vapors blown through the same into the lung.

This was the state of the art in 1908. At that time the writer combined with his brother, Julius Meyer, consulting engineer, for the purpose of constructing differential pressure apparatus which should be free from above-mentioned objections. As regards anesthesia the proposition was approached from the point of view that what has come to be known in surgery as normal anesthesia must be applicable in the

ordinary way without complication, encumbrance, or hindrance, and that every other consideration must be subordinated to the safe and

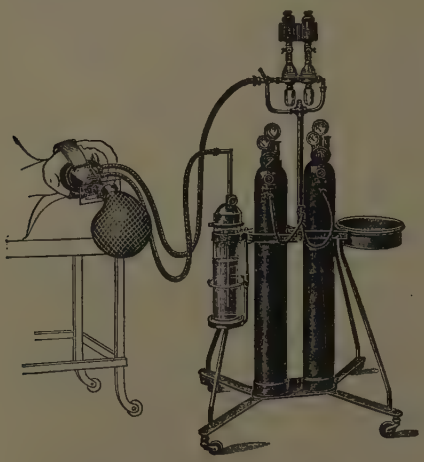

FIG. 483.—TIEGEL'S APPARATUS.

perfect performance of anesthesia in a way which every doctor has learned and can practice.

FIG. 484.—NARCOTIZING ATTACHMENT OF TIEGEL APPARATUS.

We have had the benefit of the study, the experiment, and the experience of those preceding us. We have combined all the features they

have found to be successful and improved upon them, just as the next experimenter will improve upon us.

On the side of positive pressure the Sauerbruch-Petersen-Engelken way of housing the anesthetizer with the patient's head formed our starting-point. A cabinet of approximately 80 cubic feet contents (Figs. 485, 486), large enough for two anesthetizers, was built up of wire screens and made air-tight from the inside by means of a bag of rubber sheeting, through which conversation between surgeon and anesthetizers can be carried on. The anesthetizers within are placed in the current of fresh air; the exhaust is near the head of the patient, so that the vapors

FIG. 485.—WILLY METER'S POSITIVE DIFFERENTIAL PRESSURE CABINET, EXPERIMENTAL CONDITION.

of the narcotic are absorbed by the patient only. The air is changed once every minute. For the enclosing of the patient's head the Brauer idea served as guide. Outside, against one side of the cabinet and projecting far out from the same, a pyramidal box was placed, opening inward and closed in front by a rubber collar through which the head of the patient is passed. The bottom of this head box, or hood, is horizontal, and serves to carry an adjustable support for the patient's head, offering, besides, room for instruments, etc. The top of the box pitches downward, and consists of a large pane of glass, below which the patient's head can be seen from the outside. Above the pane is placed a mirror in which the anesthetizers, glancing up, see the field of operation reflected.

The cabinet has an air-lock by means of which the anesthetizers can be reached without interruption of the difference in pressure. There is room inside for oxygen tanks and for apparatus for applying the anesthetic. The anesthetizers have access to the head of the patient, with plenty of room all around the same for the carrying on of whatever manipulations are required during anesthesia. Lately the inside covering of rubber sheeting has been replaced by copper sheeting, and the use of rubber

FIG. 486.—WILLY MEYER'S POSITIVE DIFFERENTIAL PRESSURE CABINET AS USED FOR HUMAN SURGERY.

sheeting been restricted to sound windows for conversation between the surgeon and anesthetizer in the two vertical sides of the head box. Another sound window is arranged in the copper near the pressure valve for conversation between the anesthetizers and the mechanic. As this chapter deals with anesthesia only, other features of and improvements in this cabinet are not mentioned here.[8]

On the side of the negative chamber (Fig. 487), Sauerbruch's chamber served us as guide. A new departure has been made by omitting in the

FIG. 487.—WILLY MEYER'S UNIVERSAL DIFFERENTIAL PRESSURE CHAMBER. EXTERIOR VIEW. EXPERIMENTAL CONDITION.

FIG. 488.—WILLY MEYER'S UNIVERSAL DIFFERENTIAL PRESSURE CHAMBER WHEN ERECTED FOR ANIMAL EXPERIMENTATION. INTERIOR VIEW.

wall the opening for the passing through and out of the patient's head into the open air. Instead of that, the patient's head is placed into a positive differential pressure cabinet erected within the negative chamber (Figs. 488, 489). In order to make that possible, the size of the latter has been increased to approximately 1000 cubic feet contents

FIG. 489.—INTERIOR VIEW OF WILLY MEYER'S UNIVERSAL DIFFERENTIAL PRESSURE CHAMBER AS USED FOR HUMAN SURGERY.

(16 × 8 × 8 feet). When the patient's head is in the positive cabinet, his body rests in the negative chamber on the operating-table in front of the positive cabinet (Fig. 490). Anesthesia is here, therefore, the same as above described for the positive cabinet.[8]

A feature of the anesthesia in my apparatus is the application at intervals to the patient of rhythmic pressure by means of the

valves, which are operated by hand. The air-supply is so apportioned that the pressure within the cabinet as well as within the chamber responds immediately to the slightest change in the setting of the valves. By closing and opening them more or less, differences in pressure are produced, the extent of which is read on the gauge. Using the gauge as guide, the valve can, therefore, be handled in such a way that the pressure rises and falls rhythmically between limits determined by the surgeon. If the glottis is kept open, the lung of the open side rises and falls as the pressure changes, while simultaneously the lung of the closed side breathes spontaneously on the varying levels of pressure. This procedure forms an excellent lung gymnastic and, therefore, heart stimulant, while at the same time through such deep breathing carbonic

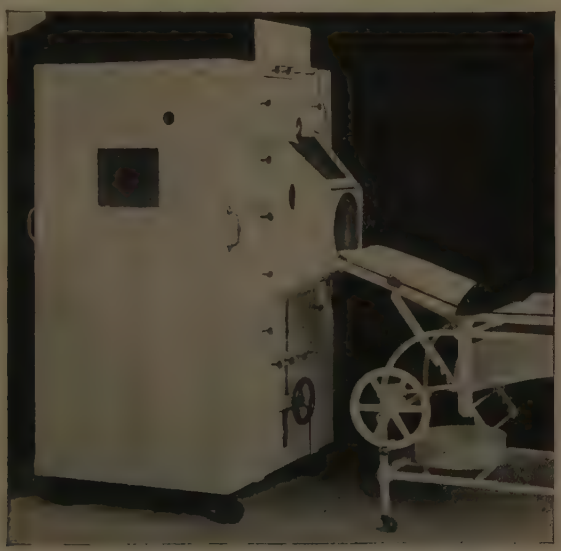

Fig. 490.—Robinson's Positive Differential Pressure Cabinet, Showing Partial Elevation of Adjustable Hood.

acid is discharged. The lung is thus thoroughly ventilated, the blood aërated, and the pulse kept even and strong.

The general lines of Engelken's and of my differential pressure cabinets have been followed in the one built by Robinson;[12] like Engelken, he locates the pressure regulation inside of the cabinet, making it the anesthetizer's duty to attend to it. He introduces the new feature of making the head-box movable (Fig. 490). He has brought out recently a combination apparatus (Fig. 491).

There are numerous other apparatus for producing differential pressure, and their omission here must not be construed as derogatory to them or a denial of their merits. The student of the original literature will find them there quoted, and can extend his inquiry if he so desires.

FIG. 491.—ROBINSON'S APPARATUS FOR POSITIVE PRESSURE BY THE MASK OR INTRABUCCAL METHOD AND FOR INTRATRACHEAL INSUFFLATION.*

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CHAPTER CL.

ANESTHESIA BY INTRATRACHEAL INSUFFLATION.

By S. J. Meltzer, M.D.,
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Intratracheal Insufflation.—The method of intratracheal insufflation consists in driving air, by means of external pressure, through a tube which has been introduced through the mouth and larynx deep into the trachea. The insufflated air, driven by the same external force, returns through the space between the tube and the wall of the trachea and escapes through the mouth and nose. The air-stream has to be interrupted several times a minute for only about two seconds at a time. When the size of the tube, the rate of interruption, and the degree of pressure are properly selected, the intratracheal insufflation is capable of maintaining properly the life of even completely curarized and anesthetized animals or of individuals with a widely open double pneumothorax without any efficient respiration of their own. By various series of experiments it was established that the intratracheal insufflation, far from being injurious to the respiratory organs, serves, by virtue of the recurrent air-stream, as a reliable safeguard against an invasion of foreign, infectious matter from the pharynx.

Anesthesia by this Method.—When the insufflated air, before it enters into the intratracheal tube, passes through the vapor of an anesthetic, the insufflation is capable of maintaining anesthesia. By extensive experimentation with ether it was firmly established that the administration of this anesthetic by intratracheal insufflation presents an efficient and safe method of anesthetization: (1) A number of dogs were kept under profound ether-anesthesia continuously between twelve to fourteen hours. About fifteen minutes after the discontinuation of the insufflation the animals recovered from the anesthesia and showed later no ill after-effects. During these long-lasting anesthesias the animals required very little supervision, and only about 600 to 800 c.c. of ether were consumed by each dog. (2) About 40 dogs, poisoned by fatal doses of strychnin, were kept deeply under the influence of ether-anesthesias from four to eight hours, and recovered completely without unfavorable incidents ascribable to the anesthesia. (3) Ether-anesthesia by intratracheal insufflation was tested on about 400 dogs for various experimental operations; it proved exceptionally satisfactory. In many instances several animals were anesthetized simultaneously, deriving the air-pressure from the same air-pump; they required no other attention than keeping the respective bottles filled with ether and an occasional

examination of the respiration. (4) Elsberg, of the Mount Sinai Hospital, and Peck, of the Roosevelt Hospital, New York, have employed the intratracheal insufflation for ether-anesthesia in about 650 operations upon human beings with complete satisfaction. The patients are perfectly quiet and in good condition during the anesthesia, awake soon after the removal of the insufflation, feel no ill-effects from it, are remarkably free from operative shock, and suffer strikingly little from postoperative vomiting.

The experimental studies demonstrated that there is a broad zone for the ether-anesthesia by insufflation which is practically free from all danger. The anesthesia may be pushed confidently until there is a complete relaxation of all the muscles and an abolition of all the reflexes. It is a peculiar feature of the anesthesia by insufflation that within the safe zone the degree of anesthesia brought about by a certain " dose " of the anesthetic is practically stationary, that is, the degree of anesthesia remains the same as long as the degree of the administration of the ether remains the same. The degree of etherization which brings about a complete relaxation, therefore, never leads to the appearance of dangerous symptoms. The recurrent air-stream, which forcibly carries off some of the ether, apparently prevents a dangerous accumulation of the anesthetic. If, however, the administration of the ether is pushed far in excess of the need for a complete anesthesia, the danger line will finally be overstepped. But here, again, we meet with the great advantage that the downward course is quite protracted, that there are definite warnings, and that the relief is ready at hand. In cases of excessive anesthesia the spontaneous respiration of the animal becomes more and more shallow until it completely disappears. When the blood-pressure is registered, it is found that the various undulations (respiratory, Traube-hearing, etc.) disappear first, then the pressure begins to sink and continues to fall slowly, while the pulse-pressure and the frequency of the heart-beats continue unchanged. Finally, the heart stops. The heart continues to beat sometimes for an hour and longer after the respiration has stopped completely. Now, during this long interval a mere reduction in the degree of anesthesia will unfailingly bring back blood-pressure and respiration to a normal state again. It is still better, of course, when the anesthesia is entirely omitted; the insufflation is then simply artificial respiration. It is one of the great advantages of this method of anesthesia that efficient artificial respiration can be instituted at any moment simply by the turning of a stopcock.

Most of the studies in anesthesia were made with ether. The studies of insufflation anesthesia with chloroform have, so far, not been extensive enough to compare properly its effects with those of ether. However, our experiences are extensive enough to permit the following brief statements: Chloroform, administered by intratracheal insufflation, produces anesthesia much more rapidly and profoundly than ether and with a much smaller dose of the anesthetic. Operations lasting only two or three hours can be safely carried out with chloro-

form, but it has to be carefully supervised. An excess of chloroform has a more rapid detrimental course than an excess of ether, and evidently the heart itself is much more readily affected under chloroform than under ether. The further fact that prolonged use of chloroform (four hours and longer) by insufflation led in several experimental cases to considerable irritation of the lungs, must not be overlooked.

Woolsey, of Brooklyn, employed nitrous oxid and oxygen in 19 cases with good success. (See also Cotton and Boothby.)

I wish especially to emphasize the fact that the use of the intratracheal insufflation in human surgery ought to be carried out with great caution, especially at this early stage of its introduction, lest the unfamiliarity with some little details might lead to disastrous results. There have been already three fatal cases, and one with a threatening complication, following intratracheal insufflation. In one fatal case one of the tubes in the ether bottle was prolonged under the surface of the ether, and by turning a wrong stop-cock ether was driven into the trachea. Such a fatal mistake is, of course, entirely avoidable; no tube should come in touch with the ether itself. In the second fatal case the patient died with signs of asphyxia and emphysema appeared in the neck. In the third case the tube was permitted to slip deep into the bronchus and the pressure to rise to 120 mm. Hg. The lung broke and the patient died of an acute extensive pneumothorax. In the fourth case cyanosis and difficult breathing set in two minutes after the removal of the intratracheal tube, and here, again, emphysema made its appearance. This patient recovered quickly. The second and fourth case had in common the fact that the tube was introduced into the trachea with great difficulty. In the fatal case the bellows was used for insufflation without a safety-valve, in the other case the pressure was provided by an oxygen "bombe." I am quite sure that in both cases the forced introduction of the tube caused an injury to the mucous membrane of the larynx which gave rise to some spasm of the glottis. The increased narrowness of the intraglottideal space made the escape of air from the trachea more difficult and led to two evils: a greater increase of pressure within the lungs and a greater accumulation of carbon dioxid. As there were no autopsies, nothing can be said definitely about the nature of the possible injury or about the mechanics of the development of the emphysema. I believe that the avoidance of the use of force in the introduction of the tube, the use of tubes with a fairly small diameter, and the interpolation of a safety-valve in the system of tubes would prevent such occurrences. It may be pointed out that neither Elsberg nor Peck, who employed the method in a comparatively large number of cases, has met with such accidents.

In the following paragraphs a few details will be given regarding the selection of the intratracheal tube, its introduction, and the insufflation apparatus, which may be of some service to those who wish to test the method.

The Intratracheal Tube and its Introduction.—The tube to be introduced into the trachea must be flexible and elastic; it has to possess some degree of resistance, but it should not be too rigid. In our experimental work we are using flexible stomach-tubes or English catheters. Elsberg recommends silk-woven catheters. *The diameter of the tube should be rather too small than too large;* it need never be larger than 8 mm. with a lumen of 4 mm. In length it should measure not less than 35 cm. It is preferable that the opening should be at the end of the tube.

Previous to the introduction of the tube the patient should be narcotized in the usual way. In our experimental work the introduction of the tube is accomplished in the following manner: The mouth of the well-narcotized animal is kept open by means of a gag, the tongue pulled

out, and by means of a curved forceps the frenum of the epiglottis is grasped and the epiglottis pulled back; the introduction of the tube into the larynx is then a very simple matter. It is probable that this method could be employed also in human surgery. Elsberg and Peck introduce the tube by means of the Jackson direct laryngoscope. Cotton and Boothby described a tube-introducer. This method has proved very satisfactory in their hands. I would emphasize again that no special force should be used in introducing the tube. After the tube enters the trachea, it should be pushed gently forward until it meets with a resistance; the end of the tube is then usually in a deep place in the right bronchus. The tube should then be withdrawn about 5 or 6 cm. Some arrangement has to be improvised to keep the tube secured in the desired position, and at the same time protect it against

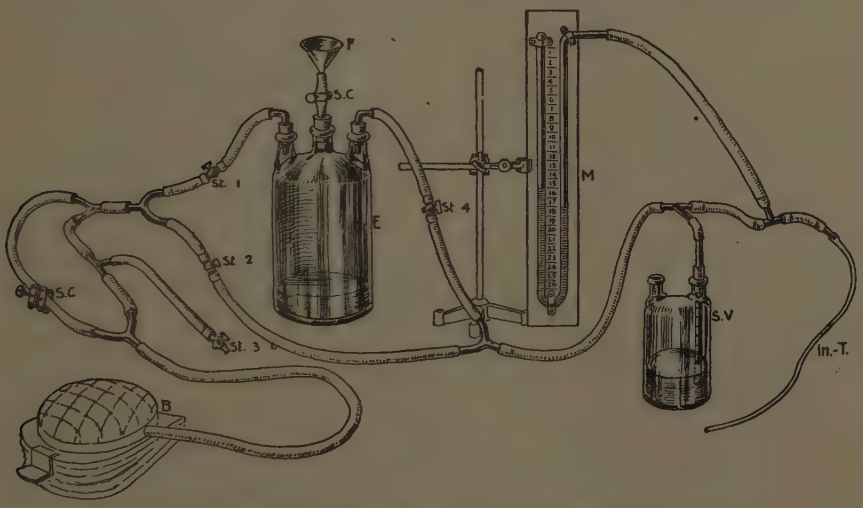

FIG. 492.—APPARATUS FOR ANESTHESIA BY INTRATRACHEAL INSUFFLATION.
(For description see p. 972.)

compression by the teeth. Elsberg devised for this purpose a clip held by an elastic wire shaped to fit over the ears like a pair of spectacles. The surgeon ought, of course, always ascertain whether the tube is actually in the trachea, and not, perchance, in the esophagus.

The Insufflation Apparatus.—Elsberg has developed a very efficient apparatus with which he, as well as Peck, carried on their work with such good results. I shall not attempt to give a description of it, as a description and a picture of Elsberg's apparatus is given in the chapter on Thoracic Surgery (p. 395). The reader is also referred to Elsberg's[1] detailed article on this apparatus. An apparatus devised by H. H. Janeway (Vol. VI., p. 398) is used in the Presbyterian and New York Hospitals, New York. I wish to describe here a simple and inexpensive arrangement (Fig. 492), which fulfils the various re-

[1] Annals of Surg., February, 1911.

quirements of the method in a very satisfactory manner, and which at the same time can be easily put together without the aid of a skilled mechanic.

By means of a glass-blower's foot-bellows (B) air is driven at will through a system of branching tubes into the intratracheal tube (In.-T.). The first branching of the tubes is introduced for the purpose of regulating the interruption of the air-stream. From the right branch a tube is led off laterally, carrying a stop-cock (St. 3), which is to be used for the interruptions of the air-current. During the opening of the stop-cock a part of the air-current continues through the left tube, thus preventing too great a reduction of the pressure, which is undesirable. By means of a screw clamp (S. C.) the amount of air which is to pass through the left tube can be regulated; a narrowing of this tube causes a greater collapse of the lungs during the interruption. The second branching of the tubes is introduced for the purpose of regulating the anesthesia. The ether bottle (E) is interpolated in the left branch; the right branch runs uninterrupted outside of the bottle to unite with the part of the left tube which comes from the ether bottle. When the stop-cock in the right branch (St. 2) is closed, all the air passes through the ether bottle; when, instead, both stop-cocks in the left branch (St. 1 and St. 4) are closed, only pure air reaches the intratracheal tube, and when all three stop-cocks are open only one-half of the air is saturated with the anesthetic. By partial closing of the stop-cocks various degrees of anesthesia can be obtained. The third opening in the ether bottle carries a tube with a funnel (F) through which the bottle is filled with the anesthetic; the tube is otherwise kept tightly closed by means of a screw clamp (S. C.). All three rubber stoppers are firmly and permanently wired down to resist various pressures. When the ether bottle is to be refilled during insufflation, both stop-cocks on the left side are closed, while the one on the right side is open.

The tube which connects the anesthesia circle of tubing with the intratracheal tube (In.-T.) carries two lateral tubes; one is connected with a manometer (M), which needs no description, and the other leads to a safety-valve (S. V.) of a simple construction. To the rubber tubing is attached a graduated glass tube, the lower end of which is immersed under the surface of the mercury in this bottle to a depth corresponding to the pressure which is desired for the intratracheal insufflation. For instance, if the pressure should be not more than 20 mm. of mercury, the glass tube is immersed just 20 mm. below the surface of the mercury. The glass tube is kept in the desired place by means of a rubber ring resting upon the opening of the mercury bottle. This device gives great safety to the working of the method. No matter how strong and irregular the bellows is worked, the intratracheal pressure could never rise above the one arranged for; the surplus of air escapes through the tube from under the mercury.

In this arrangement a wash bottle can be inserted containing warm Ringer's solution, which would serve as a filter as well as a source for heat and moisture. In our experimental work we never used it and never missed it.

The working of the bellows, which never need be too rapid and energetic, the interruptions of the pressure, which should be done about six to eight times per minute, and which need not be done at exactly regular intervals, and the watching of the manometer can be entrusted in an emergency to the care of a person who need not be a physician, and who may, if necessary, be placed at a distance from the patient. The condition of the patient can then be controlled by a physician or even a nurse, who watches the color of the patient, and especially the respiration. When this becomes too shallow and infrequent, the anesthetic should be reduced. The anesthesia should be kept at that degree which is just sufficient to keep the patient completely quiet, which may often take place even while the lid reflex is not yet completely abolished. We have established experimentally that the anesthesia sets more quicker and is deeper the larger the diameter of the bottle which contains the anesthetic and the higher the column of the anesthetic.

(Within the bottle, in order to avoid forcing the ether itself into the trachea, the end of the glass tubes penetrating the stoppers *should always remain at a distance from the surface of the anesthetic.*) When the diameter of the intratracheal tube is a little too small, it may happen that the patient will not become readily anesthetized. Slight, short pressures with the finger upon the hyoid bone will soon have the desired effect. For patients who are refractory to ether, a bottle containing chloroform should replace the ether bottle, at least for the induction of the anesthesia. The diameter of the chloroform bottle should be smaller than that of the ether, and it should contain only a small quantity of the anesthetic. It is advisable to have such a chloroform bottle ready at hand; the change from one anesthetic to the other would be a matter of only a few seconds. It ought also to be kept in mind that chloroform needs more watching than ether.

After finishing the operation and discontinuing the ether, pure air should be insufflated for a few minutes before the removal of the tube to drive out as much as possible of the lingering anesthetic.

In using intratracheal insufflation some points should be kept in mind which I wish to emphasize once more. The tube should never be introduced with too much force, and its diameter should be rather too small than too large. There should be a safety-valve in the apparatus which permits the intratracheal pressure to be kept at a definite constant height. It is advisable to begin with a low pressure and to increase it, after it becomes evident that the tube is not too large. There should be at least six interruptions per minute, but the interruptions should last only about two seconds. There should never be marked collapse of the lungs, especially when the thorax is open, as it requires much more pressure to redistend a lung than to keep up the distention. During the anesthesia with ether the appearance of so-called apnea calls for immediate withdrawal of the anesthetic; it means that the medulla oblongata is succumbing to the influence of the ether. The insufflation with pure air is the best cure for this state.

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CHAPTER CLI.

INTRAVENOUS ETHER-ANESTHESIA.

By Prof. Dr. H. Kümmell,

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The very favorable results achieved by Burkhardt with intravenous injection of an anesthetic, thereby carrying out the ideas first promulgated and experimentally tested not only in animals, but in human beings by Witzel and others, must be regarded as a distinct progress in anesthesia.

Every innovation in medical science, if it is unusual and apparently not entirely free from danger, is received with a certain amount of reserve and tried with the greatest caution, and to this general rule intravenous anesthesia forms no exception. Very few surgeons have been willing to subject the method to further trial, much less make practical use of it on a large scale. Quite recently, however, several publications have appeared, giving the results obtained by this new method of anesthesia with a variety of medicinal agents. Burkhardt's latest papers, in which he reports more than 250 cases of intravenous anesthesia with favorable results, prove that, providing the indications in various groups of diseases are carefully worked out, this new procedure is worthy of attention. In my own opinion it cannot be successfully replaced by any of the older methods of anesthesia.

In one of the first communications published by Küttner subsequent to the appearance of Burkhardt's papers, in which he reports 23 cases of intravenous anesthesia with ether, the author took a stand against the further employment of the method because in 1 case the anesthesia was interrupted by the formation at the site of injection of a thrombus as large as a pea, and in a second case alarming cyanosis developed as the result of pulmonary embolism. Another paper, by Clairmont and Denk, of von Eiselsberg's clinic, is likewise unfavorable to the intravenous method; on the strength of numerous animal experiments they conclude that it is too uncertain and too dangerous.

The experience we have had with intravenous ether-anesthesia is so very favorable that I cannot but regard its more general employment as a consummation to be devoutly wished for. We have so far used ether in 130 cases—a small number, it is true, in comparison with the total number of cases in which we have to employ general anesthesia in the course of a year, which amounts to several thousand. The cases were selected for trial with the greatest care, and in every case a careful record was kept of the effect produced on the general

condition of the patient, on the kidneys, heart, blood, and vessel walls. From the outset we realized that this method would never take the place of scopolamin, morphin, ether, or chloroform, which we administer with the Roth-Dräger apparatus. But in the course of our observations we gained the conviction that in various groups of cases intravenous anesthesia, owing to the special mode of introducing the anesthetic and its stimulating effect on the organism, renders most excellent service and cannot be replaced by any other method.

This intravenous method seems to me very well adapted to operations on the face and head in general, particularly to operations in the mouth and pharynx, on the upper jaw, and at the base of the skull (tumors of the hypophysis, etc.), as well as operations on the neck. In operations of this kind the anesthetizer gets in the operator's way. The necessity of constantly taking away the mask and putting it back again because it gets into the operative field, and the consequent incompleteness of the anesthesia, are avoided by employing the intravenous method. We obtain a uniform, uninterrupted anesthesia, controlled at a point removed from the operative field, and one which permits the operator to do his work on the face and other regions previously enumerated without being hampered by the anesthetist. At the same time, the prompt introduction of saline solution which the method renders possible is often of the greatest advantage in these operations, which are frequently attended by severe hemorrhage.

In 31 cases of tumors of the upper jaw, tumors of the larynx, thyroid gland, base of the skull and calvarium generally; in operations on tumors of the hypophysis, on carcinoma of the tongue, and in plastic operations on the nose, the method has been found most useful on account of the uniform, undisturbed character of the anesthesia obtained and the freedom from interference with the operator and his assistants.

In another group of cases, namely, patients who had become greatly reduced and emaciated from long-continued general disease, intravenous anesthesia was found to work very satisfactorily; patients who at the very beginning of the anesthesia require an intravenous injection of saline solution to support the strength and make it possible to administer a general anesthetic at all. It is evident that a method which makes it possible in enfeebled patients of this type to add an anesthetic to the saline infusion which not only enhances its stimulating effect, but at the same time and without further manipulation puts the patient to sleep in the most acceptable manner, is absolutely ideal in the group of cases mentioned. As a rule we find the pulse much stronger after the operation than before, and the patients not infrequently leave the operating-room with a better heart action and brighter appearance than they exhibited before the operation. Recovery from the anesthetic is prompt and unattended by discomfort. Nausea and vomiting have not been observed in a single case—a factor which is not to be underestimated after a serious laparotomy in patients of this type. The small quantity of ether required with this method

explains the relative comfort experienced by the patient when he comes out of the ether-sleep.

Intravenous anesthesia was employed in 9 cases of cancer of the esophagus and cardiac end of the stomach, 31 malignant tumors of the stomach, 11 benign stenoses of the pylorus, 4 tumors of the rectum, tumors of the cecum, total extirpation of a carcinomatous uterus, ectopic gestation, a number of malignant tumors of the abdominal cavity, disease of the kidneys, diffuse peritonitis, a patient with fungus in the knee-joint, tumors of the thigh, and numerous other cases.

Taking up the important question of the dangers of the method, I have the impression that they have been very much exaggerated because the subject has been approached from a theoretic viewpoint. It was assumed on theoretic grounds that local thrombus formation must necessarily take place; the obvious danger of embolism was quite naturally taken for granted. It is not to be denied that these theoretic considerations are justified, and, realizing such possibilities, we have approached this new method with the greatest caution. Thrombus formation would constitute the weakest point of the method if it were true that embolism might be expected to take place in a considerable proportion of the cases. The pulmonary embolism with alarming symptoms, which occurred in Küttner's case, caused him to desist from further use of the method, and I have no doubt that other surgeons have been deterred by the same reason from continuing its use.

But what are the actual facts, so far as we know, with regard to the formation of thrombi and consecutive embolism? So far we have not experienced pulmonary embolism in any of the cases in which we have used intravenous anesthesia, and Burkhardt has had the same negative experience, although we have frequently observed local thromboses at the point where the vein was punctured. In 3 cases the patient complained of pain over the site of the injection in the left arm soon after the operation, and the pain continued for several days. The vein was thickened for a distance of 3 to 5 cm. and distinctly palpable, but no further symptoms developed. As many of our operations were performed on patients in an advanced stage of disease and debility, many of them suffering from advanced carcinoma, who died in the course of the disease soon after operation, we had numerous opportunities of controlling our clinical observations at the postmortem table. These examinations failed to show any special pathologic changes in the lungs, heart, or kidneys which could be referred to the anesthetic. On the other hand, in our first cases that came to autopsy thrombosis was present at the site of the infusion. In these first cases, in which we employed the technic recommended in Burkhardt's early papers, that is to say, uninterrupted infusion, instead of the later modification consisting of continuous anesthesia and supplementary administration of physiologic salt solution, which will be described presently, the thrombi were quite dense and sometimes occluded the collateral blood-vessels. In our remaining cases the thrombi were much shorter and softer, no firmer, in fact, than the thrombi which are exceptionally seen post-

mortem after a simple infusion of salt solution, and quite frequently when digalen or adrenalin is added to the solution.

In another group of cases we were able to study the effect of intravenous anesthesia on thrombus formation by postmortem examination, and in none of these cases was thrombosis observed. These favorable results are to be attributed to the development and improvement of the technic, which are chiefly the work of Mr. Schmitz-Peiffer. It seems to me that the danger incident to thrombus formation at the site of infusion has possibly been overestimated. Since we began to study the effect of a simple saline infusion, and particularly one containing adrenalin and digalen, we have observed thrombosis in almost every case in which a medicated infusion was employed, but have never seen a consecutive pulmonary embolus. In fact, the occurrence of embolism, except from a thrombus in the upper extremity, appears to be very rare. The intravenous administration of drugs, which has become such a popular method of treatment, would certainly have suffered a severe check if it were associated with any appreciable danger of embolism. If these minor thromboses which occur in the veins of the arm were dangerous, the infusion of saline solution containing digalen or adrenalin, which is now so frequently employed and is generally recommended as free from danger, would have to be abandoned altogether, and I am sure that no one has any intention of robbing us of these very powerful therapeutic aids. Nor have we any knowledge of unfavorable results from this method which would induce us to discard it. The same thing applies to the so-called dangers attending the adminstration of ether with saline solution; they are inconsiderable, in spite of the fact that ether, like digalen, adrenalin, and other drugs, is in a certain sense injurious to the vessel walls. The fact that it has been possible, by further improvement of the technic, to minimize or even completely eliminate thrombosis in intravenous anesthesia renders the method even more free from danger.

As for the value of saline infusion itself, we are ardent adherents of this therapeutic procedure and believe it has saved many lives. We use it frequently in a large number of cases, and, when necessary, have injected as much as 18 liters within twenty-four hours, not only without injuring the patient, but, as we believe, with the result of saving life in many instances. It is our practice, whenever edema appears below the lower eyelids and in the sclera, to interrupt the administration of saline solution temporarily, and we follow the same rule in intravenous anesthesia. The quantity which can be injected depends, of course, upon the strength of the individual, and is, therefore, extremely variable. This is the most important point in this method of anesthesia. While in the case of a greatly reduced individual, with desiccated tissues that are greedy for water, relatively large quantities of fluid can be injected, the limit beyond which the infusion may not be pushed is set much earlier in vigorous patients with a well-filled vascular system.

The chief indication for the intravenous method, as has been repeat-

edly stated, is found in the case of cachectic, emaciated, and feeble individuals after severe hemorrhage (ectopic gestation, injuries, and the like), and in patients who have been exhausted by acute disease, such as peritonitis. Another indication based on technical grounds is found in operations on different parts of the neck and head, and I do not believe that any other method of anesthesia is capable of giving such favorable results in this type of cases.

In vigorous individuals the inhalation method is to be preferred. In the presence, however, of the above-mentioned technical indications, namely, an operation on the head or neck, if the method is to be employed at all, it should be done with great care and the mixture injected into the vein very slowly. Contraindications are found in arteriosclerosis, which is usually accompanied by a high blood-pressure, severe myocarditis, and general plethora. Cardiac or pulmonary complications have never followed the employment of infusion-anesthesia, with the exception of 1 case, in which an already existing pulmonary and laryngeal tuberculosis was apparently made worse. In a case of amyloid kidney the quantity of albumin excreted during the first few days following operation was slightly increased, but in all other cases the urine was always free from albumin, blood, or renal constituents. In a considerable number of cases a venesection was done on the patient immediately after the operation, the blood being drawn from the basilic vein on the opposite side. Neither microscopic nor spectroscopic changes in the red blood-cells or in their tingibility or in the hemoglobin content were found. This may be due to the fact that the 5 per cent. ether mixture does not develop its full effect, because only 4 per cent. of ether is soluble in water to begin with, and because part of it escapes from the open vessel used in the infusion, or, if the vessel is covered, collects above the level of the fluid. This can be demonstrated by holding a burning match over the vessel, when the ether will at once begin to burn with a steady flame. It is probable that the solution which finally enters the vein does not contain more than 3½ per cent. of ether. Furthermore, it is probable that most of the injected ether is directly excreted by the lungs, as is indicated by the odor of the breath immediately after the anesthesia is begun.

Even at the time of the patients' discharge and during protracted convalescence, during which they were under constant observation, no changes could ever be demonstrated which could be in any way attributed to the effect of the method. The patients find the anesthesia extremely pleasant; headache, vomiting, and other unpleasant after-effects were never observed. The patients often asked of their own accord to be anesthetized "through the arm," having learned about its agreeable effect from their neighbors in the ward. In 5 instances intravenous anesthesia was employed twice in succession on the same patients at their own particular request.

Technic.—In the actual administration of intravenous anesthesia, just as in lumbar anesthesia, experience plays a very important part, and I have already called attention to the improvement effected in the

method by Mr. Schmitz-Peiffer, which has had the effect of practically eliminating clotting in our more recent cases. All patients up to the age of about sixty-three receive before the operation $\frac{1}{2}$ mg. ($\frac{1}{120}$ gr.) of scopolamin and 1 cg. ($\frac{1}{6}$ gr). of morphin, which is the customary dose, and this is given whether inhalation or any other form of ether-anesthesia is employed. While in partial anesthesia, the patient is placed on the operating-table, the eyes are covered, and under customary antiseptic precautions the median basilic vein is exposed and the cannula introduced as when saline infusion is administered. In order to avoid clotting as much as possible we endeavored to maintain a continuous stream, because it seemed to us that the chief cause of thrombus formation was to be sought in the manner of giving the ether only as it was needed, that is, intermittently, according to Burkhardt's original method. To obviate this we employ two separate vessels, one of them containing the ether and saline solution, the other a 4.1 per cent. physiologic saline solution. The rubber tubes from these vessels are joined and attached to a Y-shaped piece of glass tubing, one branch of which is connected by means of a rubber tube with a cannula and fitted with a stop-cock that can be easily regulated. This stop-cock makes it possible to inject very small quantities of fluid with absolute uniformity. For instance, after a sufficient quantity of the ether mixture has been given to produce a satisfactory anesthesia, the ether mixture is shut off with a clamp, and physiologic salt solution is slowly injected until the reappearance of reflexes again calls for the use of the ether mixture. The tube supplying the saline solution is then closed, and that connected with the ether mixture turned on.

This arrangement permits a constant anesthetization with accurate dosage, as the vessels are graduated and the quantity of fluid used can be accurately read off at any moment. In addition, the velocity of the stream that enters the vein can be accurately regulated by means of a stop-cock.

After ten minutes in most cases, or, in very feeble patients, after only four or five minutes and the injection of from 100 to 300 gm. (containing 4 to 5 gm. of ether), the stage of tolerance is established and the operation can be begun. No symptoms of excitement beyond very slight efforts to push things away are observed as a rule. In only 1 case, that of a young man twenty-four years of age who had been frequently anesthetized before, the stage of excitement was so severe that the method had to be abandoned. In the case of 3 other patients who were unusually excitable a small quantity of chloroform was first administered, after which intravenous anesthesia was carried on to the end without further interruption.

During our first trials, before we employed the continuous method, we twice saw a slight cyanosis, and once a degree of asphyxia which required artificial respiration. In all probability too much ether had been introduced into the organism at once in these cases, owing to our lack of experience, and this was the cause of the accidents. The cyanosis disappeared at once after the ether mixture was shut off. I

mention this especially in view of Dumont's contention that in intravenous, as well as in inhalation-anesthesia, it is quite possible to interrupt the administration of the anesthetic at once when the slightest alarming symptom makes its appearance. The rest of our anesthetizations were carried on with remarkable freedom from disturbance. The respirations were uniformly good and the pulse was usually increased in force by the introduction of fluid. No accidents except the above-mentioned slight disturbances were observed.

It was in a case of carcinoma of the cardiac end of the stomach in a greatly emaciated individual, in which an extensive resection of the stomach had to be performed in addition to the removal of the cardia or rather a portion of the esophagus 10 cm. in extent, that we used this method for the longest time. Within the space of two hours and twenty minutes 17 c.c. of the ether mixture or 85 gm. of ether were introduced. I believe that the favorable result in this severe operation and the patient's recovery after resection of a carcinomatous cardia were chiefly attributable to the stimulating effect of the intravenous method.

In another case in which a tumor at the base of the skull was removed, and temporary resection of the upper jaw was performed, 900 c.c. of the ether mixture, equivalent to 45 gm. of ether (in reality only 31.5 gm.), were used in the space of one hour and forty-five minutes.

Our results with intravenous ether-anesthesia were so favorable that we did not resort to the use of isopral and hedonal, with which Burkhardt and Feodruff obtained such good results.

In the light of our experience, intravenous ether-anesthesia is a method which, providing the indications are properly observed, is superior to any other form of general anesthesia in a large number of cases. For many conditions it is to be regarded as an absolutely ideal method because, aside from the fact that a small quantity of anesthetic is employed, it has a distinctly stimulating action, which cannot be said of any other method known up to the present time.

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CHAPTER CLII.

SUBARACHNOID (SPINAL) ANESTHESIA.[1]

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The Definition and the History of Spinal Anesthesia up to 1907 are given in Vol. V., pp. 1082, 1083.

In 1907 A. E. Barker, of London, published a report on a series of cases on which he had operated under spinal analgesia, and gave a full account of a new factor which he embodied in his technic. This was the force of gravity, acting on an analgesic solution of greater density than the spinal fluid, by which the height to which the injected solution extended in the spinal canal could be controlled and its effects localized to certain regions of the spinal cord.

This method Barker and others following him have now used for five years with safety and success, and it will be fully described.

ANATOMIC AND PHYSIOLOGIC REMARKS

The spinal cord in the adult extends only to a level with the upper border of the second lumbar vertebra, when it becomes continuous with the filum terminale, which, as a bundle of connective tissue, extends to the termination of the dural sac at the second or third sacral vertebra.

In a child the cord ends opposite the body of the third lumbar vertebra.

The arachnoid sac into which the injections are made is a more or less wide lymph-space surrounding the brain and spinal cord.

Through the foramen of Magendie and the foramina lateralia the entire subarachnoid space and its contained cerebrospinal fluid are in communication with the ventricles of the brain. (See Vol. V., p. 1084.)

Poisons dissolved in the cerebrospinal fluid, therefore, through these foramina, may gain access to the inner lymph-spaces of the brain, and thus be brought in contact with the vital nerve-centers, especially in the floor of the fourth ventricle.

The arachnoid does not closely invest the spinal cord, a wide space being left between it and the pia. This space is, however, incompletely divided into an anterior and a posterior compartment by the ligamentum denticulatum. In the posterior compartment are the sensory roots; in the anterior, the motor roots.

[1] Supplementary to Chapter LXXXI., Vol. V., p. 1082.

This ligament forms practically a partition between the two compartments, for, according to experiments made by Dönitz, colored solutions (Indian ink) injected into the posterior compartment do not penetrate into the anterior.

The posterior compartment is in the cervicodorsal portion of the spinal cord, subdivided in two halves by the posterior longitudinal ligament.

From the termination of the spinal cord, at the second lumbar vertebra, down to the end of the dural sac at the third sacral vertebra, the subarachnoid sac is an undivided space, in which the nerve-roots run to their respective points of exit as a bunch of nerve-fibers, the cauda equina, which nearly fills the entire space.

At the lower end of the spinal cord (conus medullaris) and a little below it the nerve-roots are arranged in a right and left bundle, with an intervening open space, from 2 to 5 mm. in width, on a level with the second lumbar vertebra. Lower down the nerve-roots are more evenly spread out, filling the whole space, but leaving free room for the cerebrospinal fluid to filter through.

In the cauda equina the motor roots are situated in the anterior portion and the sensory roots in the posterior.

The arachnoid is only separated by a very small space from the dura. (Vol. V., p. 1085.)

Upon the outer surfaces of the dura, in the epidural space, especially at the sides, are rich venous plexuses and loose adipose tissue.

The distance from the skin to the subarachnoid space is, in the lumbar region, generally from 4 to 6 cm., but in men with well-developed muscles it may reach a depth of from 7 to 8 cm., and in fat persons, even to 10 cm.

As to the size of the spaces between the arches of the lumbar vertebra, the third and fourth are, as a rule, larger than the first and second, while the fifth is narrower from above downward, but wider from side to side.

In abnormal cases the spinous processes of the lumbar vertebræ may, however, cover each other in a tile-like manner, rendering the introduction of a needle impossible.

Strong flexion of the lumbar spine increases the height of the interspace.

The cerebrospinal fluid is nearly as clear as water, very poor in albumin, with a specific gravity of 1.007. The quantity, according to Key and Retzius, is normally from 50 to 150 c.c.

The pressure in the lumbar region is, in the recumbent position, equal to from 60 to 100 mm. of water.

Changes in posture affect to a high degree the position of the cerebrospinal fluid.

If a coloring substance in solution be injected in the lumbar region, followed by a high Trendelenburg posture, the coloring-matter will appear at the base of the brain.

The importance of this relative mobility of the cerebrospinal fluid is

very plain, if one considers that the local anesthesia used in the injection may be diffused through the entire volume of the fluid, and so carried along the spinal cord to the brain.

It is particularly important that the poison should not reach the vital centers in a condition of concentration.

In order to prevent such a diffuse poisoning of the entire cerebrospinal fluid, and to be able to tell precisely which point is being exposed to the effect of the anesthetic, Barker employs for injection only those solutions which are heavier than the cerebrospinal fluid.

If, moreover, by the addition of a suitable substance a different viscosity be given to the solution to be injected, this will with difficulty mix with the cerebrospinal fluid, and, just as a heavy mass of oil easily changes place in a tube filled with a lighter fluid, and always stays at the most dependent point, so, by changing the posture of the patient, one will always be able to calculate at which particular point the local anesthetic is being deposited, and, above all, by the very posture to prevent the poison from reaching the cervical region of the cord *en masse*.

ANESTHETICS.

Cocain was the anesthetic first used in spinal anesthesia, but from the start it proved so dangerous, and the anesthesia was attended by so many serious complications, that the search for other agents was soon begun. Leaving out of consideration those agents which have been tried, but have been found to be unsatisfactory or too dangerous, we will now mention only those which are at present in use.

Tropacocain was discovered in 1891 by Giesel, and was first physiologically tested by Chadburne of Boston. It is readily soluble in water, making a neutral, non-irritating solution. The solution will withstand sterilization by boiling. It is one-third as poisonous as cocain, and acts as a vasodilator. The anesthesia occurs sooner than with cocain, and lasts longer. It should not be used with suprarenal preparations as it counteracts their effect.

The usual dose is from 0.02 to 0.05 or 0.06 gm. Stovain was synthetically produced by Fourneau in 1904, and was first used in spinal anesthesia by Chaput. It is readily soluble in water, of a feebly acid reaction, and possesses noteworthy antiseptic properties. The solution may be sterilized by boiling.

It has a vasodilator action and is somewhat irritating to the tissues. The usual dose is from 0.03 to 0.05 or 0.06 gm.

Novocain was produced synthetically by Einhorn and Uhlfelder in 1905. It is readily soluble in water, making a neutral solution. It may be heated to 120° C. without decomposition.

The dose of novocain is double that of stovain, while its effect is neither so deep nor so lasting.

In spinal anesthesia, besides using the least dangerous anesthetic, it is also of importance to employ the anesthetic in such a form as will do the least amount of injury to the tissues.

In this respect the tonicity of the injected fluid is not such a vital

factor in the spinal canal, in comparison with the necessity of an isotonic fluid for injection in local anesthesia.

The relation of the various agents, however, in regard to this particular question is apparent from a table by Barker, giving the specific gravity and the freezing-point of the respective substances:

	Specific gravity.	Freezing-point.
Novocain, 5 per cent. solution	1.0090	0.555
Tropacocain, 5 per cent. solution	1.0106	0.545
Stovain, 5 per cent. solution	1.0064	0.585
Cerebrospinal fluid	1.0070	

Whether or not a suprarenal preparation should be added to the anesthetic solution is a question which has now been settled.

In local anesthesia the suprarenal preparations are of great value, inasmuch as they prevent the rapid absorption of the injected substance and thus allow the drug to act more powerfully upon the infiltrated area.

In spinal anesthesia the conditions are quite different. Here the anesthetic solution is deposited in a large lymph-space, and to "incarcerate" the drug by the addition of a vasoconstrictor (*e. g.*, adrenalin) is out of the question.

Our choice of drugs lies then between tropacocain and stovain, and each has advocates who claim some particular advantage in the use of their favorite.

My own experience leads me to the conclusion that there is little or no difference to be found in their effects. The depth and duration of the analgesia produced by similar doses of either drug are practically the same, while complications, such as headache or nausea, are not more frequent after the use of one than of the other.

Of almost as great importance as the choice of a drug is the question of the density of the injected fluid in comparison with that of the cerebrospinal fluid. This subject was carefully worked out by Barker in 1907, and his conclusions are here summarized.

There are only three ways by which an analgesic solution, injected through the second lumbar interspace, can make its direct effect felt in the middorsal region or even higher, as is sometimes the case in this procedure. These are either (1) by slow diffusion; (2) by a shifting upward of the whole column of cerebrospinal fluid in which it is suspended; (3) by gravitation, if the injected compound be heavier than the liquor spinalis.

Within the subarachnoid space, while we are precluded from injecting above the second lumbar interspace, it is still desirable in many cases to affect the nerve-roots or cord as high as the middorsal region. This can only be accomplished in one of the ways indicated above, modified, of course, more or less by their combinations.

(1) Diffusion alone of one fluid in another is a slow process, and is unlikely to be the mode by which the injected fluid is spread in this procedure.

(2) Bier and his followers have aimed at shifting the injected compound upward or downward with the whole mass of the liquor

spinalis by raising or depressing the pelvis. That the spinal fluid does recede toward the head on elevation of the pelvis is undoubted, but it is difficult to imagine that it recedes to such an extent as to carry with it a mass of fluid lighter than itself the distance from the second lumbar to the fifth dorsal vertebra, some 8 or 10 inches.

It is probable that with such a fluid as he has used, the specific gravity of which is 1.0058, suspended in the liquor spinalis, with a specific gravity of 1.007, what was achieved by elevation of the pelvis was rather a more rapid diffusion of the injected fluid, due to the consequent oscillation of the liquor spinalis. This rapid diffusion would, of course, dilute the injection, and might carry it higher than was desirable.

(3) There remains, then, the third possibility, namely, the action of gravity.

This force may affect an injected fluid of *greater density* than the liquor spinalis, and carry it *through the latter* to the most dependent part of the canal. Thus, a heavier solution may behave quite differently from one of lesser density when injected into the spinal sac. It is easy to observe the behavior of one fluid injected slowly into another if the fluid be colored with an anilin dye. If both have the same temperature and specific gravity, the injected fluid forms at first a distinct colored cloud, which slowly diffuses through the mass into which it enters if the latter be in a state of rest.

On the other hand, if the injected fluid has the same temperature, but a greater specific gravity, it sinks rapidly in a definite stream to the bottom of the second fluid, and remains there as a distinct stratum without diffusion for a period proportionate to its density and viscosity. A consideration of these points shows that if we aim at localizing a spinal injection to any particular region of the cord, we can utilize the force of gravity acting upon an injected compound of greater density than the cerebrospinal fluid. Thus, the heavier injection sinks to the lowest part of the canal, independently of any displacement of the liquor spinalis. Here it remains, more or less undiluted, in contact with the surrounding structures.

A 5 per cent. solution of tropacocain has a specific gravity of 1.0106, which is considerably higher than the specific gravity of the cerebrospinal fluid, 1.007.

This probably accounts for the undoubted success which has attended the use of this compound. A 5-per cent. solution of stovain in distilled water has a specific gravity of 1.0064 and a freezing-point of 0.0585° C. This solution is lighter than the cerebrospinal fluid, and will not gravitate, but will slowly diffuse at the place of injection. We cannot, therefore, expect to obtain exactly uniform results if we employ solutions of widely different densities. A failure to appreciate this may largely account for the irregularities which have been reported in the action of these drugs.

To raise the specific gravity of the stovain solution Barker has added 5 per cent. of glucose to the injected fluid, so that a solution containing 5 per cent. stovain plus 5 per cent. glucose and aqua destillata (90 per

cent.) has a specific gravity of 1.0230. This solution is heavier than the cerebrospinal fluid, and will, on injection, gravitate to the lowest portion of the spinal canal. The glucose has no irritating effect when thus injected, and, beyond rendering the solution slightly viscid and thus helping localization, its addition has little or no action on the contents of the canal.

With such a solution of comparatively high density and viscid character, diffusion and consequently dilution of the stovain is limited. Thus, a smaller dose can produce a full effect, and the drug, by means of gravity, be so localized as to exert its specific action at the desired level of the cord.

TECHNIC.

For use in spinal analgesia the "Record" syringe of 2-c.c. capacity is certainly the best. The needle has a close-fitting stylet, and the point is oblique and hollow, so as to secure sharpness without too much lengthening of the terminal opening. As the operator is dealing with very small amounts of injection fluid, and the loss of 2 or 3 drops would make a considerable difference to the extent of the analgesia, a means has been devised by Barker to ensure the delivery of all the injection compound through the point of the needle.

This consists of a second cannula, slender enough to fit the first hollow needle loosely and long enough to project beyond its point about 1 mm. when pushed home. This cannula is attached to the syringe, which is filled with the solution through it. (Vol. V., p. 1095.)

Our next consideration is how to pierce the lumbar dural sac with the point of a needle, and through it inject our analgesic solution below the level of the spinal cord.

The configuration of the bones below the fourth lumbar spine makes a needle puncture here a matter of great difficulty, so that our choice of a puncture spot is restricted to the second or third interspaces of the lumbar vertebræ. Here the sac can be reached between the laminæ, or the needle can be thrust exactly in the middle line between the second and third or third and fourth spines.

It is now generally acknowledged that puncture in the middle line is the easiest and safest method. Here the puncture is least painful and there is less risk of wounding any nerve structure or vessel if the needle is kept true to the middle line and only just penetrates the dural sac completely. At either side there is a possibility of touching the strands of the cauda equina.

Besides this, any small amount of fluid injected in the middle line can spread freely through the liquor spinalis, whereas, if delivered among the nerves of the cauda equina on either side, it may be entangled there, and tend to pass upward or downward in their interstices on that side only, and so fail to reach the general cavity of the spinal sac. This may produce an effect too low for the contemplated operation or a one-sided analgesia. The middle line, therefore, is the preferable site for the entrance of the hollow needle. Here the analgesia compound passes

freely into the spinal fluid and can move unhindered upward or downward from the point of entry. (Vol. V., p. 1096.)

A convenient guide to the site of injection is the fourth lumbar spine, which is on a level with the highest point of the iliac crests; a line joining these two points across the back will indicate this spine. (Vol. V., p. 1097.)

The hollow needle is thrust through the skin just above this or the third spine, and its point aimed straight forward and a little upward. If this is accurately done, no difficulty, as a rule, is experienced in reaching the middle of the dural sac. In some very stout people the spine may be difficult to feel with the finger, and the point of the needle may strike bone; its upward slant is then changed and the needle point thrust in a lower direction. This usually suffices to pass the spine without the necessity of a fresh skin-puncture if the back has been well rounded in order to obtain the greatest amount of separation between the lumbar spines. With a little practice lumbar puncture becomes quite easy, though in early attempts some difficulty may be encountered.

Whether, during the puncture, the patient should sit on the edge of the table, with the back rounded to its maximum, or lie on his side with the knees well drawn up, depends on the site of the operation and the height of the required anesthesia. Spinal puncture is certainly easier in the first position.

To illustrate the procedure, let us take a case requiring operation for inguinal hernia on the right side, with possibly some omentum in the sac. Here we must aim at obtaining analgesia up to the ensiform cartilage, which means that the analgesic solution must be brought into contact with the nerve-roots as high as the sixth dorsal vertebra.

The needle, cannula, and syringe are boiled for ten minutes in plain water to ensure their sterility. When cool, the cannula is fitted to the nozzle of the syringe. One of Billon's "ampoules," containing the sterile stovain—glucose solution—is now taken and the end is broken off. The cannula is introduced through the broken end and the fluid is drawn up into the syringe. Bubbles are dislodged, and all fluid except the required dose is expelled, and the syringe is laid aside on a sterilized towel. The patient has meanwhile been placed on the operating-table and his confidence established by a few words.

The skin over his lumbar region has been previously cleansed as carefully as the area for operation. The position of the patient on the table now demands the operator's attention. For an operation on the right side of the body he is placed lying on that side, so that the nerves to that region may be most deeply affected. His head and neck are raised on pillows, and to ensure that the analgesic solution reaches the sixth dorsal segment the buttocks are raised by a padded 1-inch board, placed under his right trochanter. This raises his pelvis about 1 inch, or sufficiently high to cause the sixth dorsal vertebra to be the most dependent part of his spinal column.

Great care must be taken that the head and neck are sufficiently raised to prevent the injected fluid from running higher.

His knees are now flexed on his abdomen, and his back rounded as much as possible in the lumbar region. The skin is finally cleansed and a sterile towel is laid across the pelvis, through which the iliac crests are felt and the fourth lumbar spine determined. The skin on either side of the selected interspace (second or third lumbar) is then steadied by two fingers, and the needle, with stylet in position, is sharply thrust through the integument in the middle line to a depth of 1 inch. The stylet may now be withdrawn.

The needle is then pushed firmly through the interspinous ligaments until the dural sac is punctured, when the spinal fluid flows out in rapid drops or, more rarely, in a continuous stream. This flow of cerebro-spinal fluid is most important, as it is our only guarantee that the sac has been reached by the needle. If the drops come slowly, the needle point may not be completely within the sac; it should then be rotated on its long axis, when a faster flow usually issues from the stem.

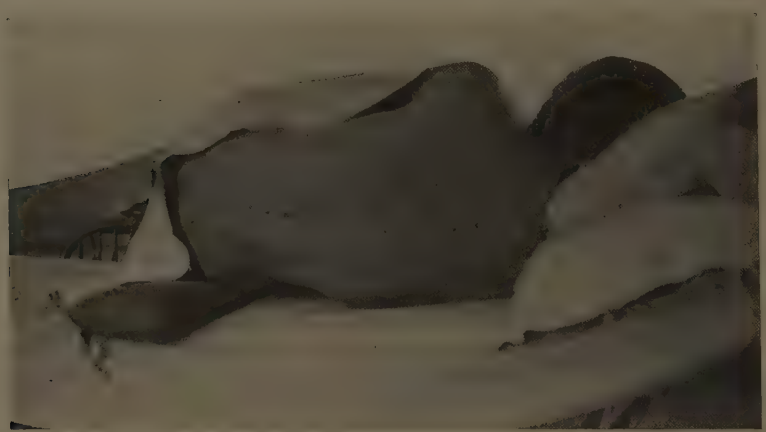

FIG. 493.—POSITION OF PATIENT FOR INJECTION IN OPERATION FOR RIGHT INGUINAL HERNIA. The head and pelvis are raised so that the sixth dorsal vertebra is the most dependent part of the column. The dorsal and lumbar spines are dotted.

In no case should the analgesic solution be injected until the flow of spinal fluid is satisfactory.

When 2 or 3 c.c. of liquor spinalis have escaped into a measuring glass the slender cannula attached to the loaded syringe is inserted through the hollow needle and pushed gently home; the measured solution is then injected into the sac by a slow thrust of the piston. The needle, cannula, and syringe are now rapidly withdrawn together and the puncture is covered with sterile plaster. Throughout this procedure the patient is lying on his right side, and the position is still maintained for two or three minutes.

By this time the solution has gravitated to the most dependent part of the spinal canal and produced its analgesic effect on the side on which he is lying.

The height of the analgesia is now noted, and, if satisfactory, the

patient is gently rolled on to his back, when the left side of his body becomes quickly analgesic. The board elevating his pelvis may now be

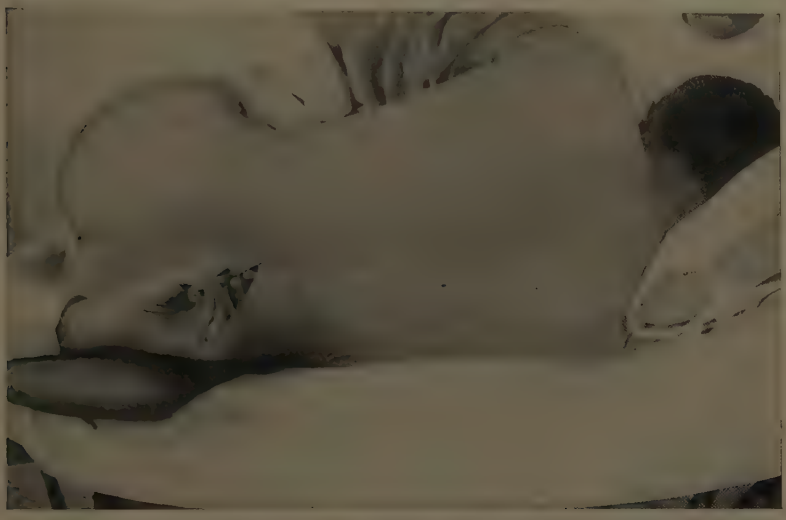

FIG. 494.—THE NEEDLE OF STRINGE IN POSITION AFTER THE INJECTION HAS BEEN COMPLETED IN AN OPERATION FOR RIGHT INGUINAL HERNIA.
The elevation of head and pelvis are here seen.

removed. As a rule, two minutes elapse after the injection before the patient feels a numbness in his feet, then the perineum becomes anal-

FIG. 495.—POSITION OF PATIENT DURING INJECTION FOR OPERATION ON HEMORRHOIDS.
The lower towel half covers the fourth lumbar spine.

gesic, and later the trunk, as high as the nerve-supply reached by the injection.

A screen should now be placed in front of the patient, as it is seldom desirable that he should see the manipulations of the operator, and if possible an assistant or nurse should converse with him, and so distract his attention from the matter in hand. At the conclusion of the operation the patient should be gently lifted into bed, with his head and shoulders raised.

For an operation on the perineum a simpler process is available. Here the analgesia is not required at a high level, so no elevation of the pelvis is necessary. After completion of the usual preparations, the patient is placed in a sitting posture across the end of the operating-table. His feet rest on a chair, and he is directed to place his elbows on his knees and his head on his hands, and so to round his back that the greatest separation is obtained between the lumbar spines. The fourth

FIG. 496.—AN OPERATION FOR RIGHT INGUINAL HERNIA, SHOWING THE SCREEN IN POSITION AND THE HEAD ELEVATED.

lumbar spine is defined, and the needle thrust into the skin immediately above it. When the lumbar sac is reached the injection is carried out as described, and the patient is then gently moved into the lithotomy position, with his head and shoulders well raised. In two or three minutes the anus becomes insensitive and its sphincters completely relaxed, when the operator can proceed to work.

A notable point in this procedure is the complete muscular relaxation which is obtained both after the use of tropacocain and stovain. This is especially remarkable during anal and abdominal operations. The muscles are found flaccid and toneless, and there is an entire absence of that straining which so frequently hampers a surgeon in cases where a general anesthetic is employed.

The most constant phenomena following an injection of this solu-

tion are a loss of the knee, plantar, and cremasteric reflexes, subjective sensations of numbness and tingling in the feet, and analgesia of the perineum, feet, legs, scrotum, and penis, gradually rising on the abdomen. Loss of painful sensation appears before sensations of heat and cold are abolished, while tactile sensation is the last to disappear and the first to return as the effect of the drug passes off.

During the operation, most frequently about fifteen minutes after injection, the patient sometimes becomes pale and sweats, he may be nauseated and vomit, but, as a rule, this passes off in five minutes. The pulse-rate is usually slowed and the blood-pressure lowered. Respiratory distress, as evidenced by "air-hunger" and inability to cough, is sometimes seen. This is dependent on intercostal paresis from high analgesia, but it does not affect all patients to the same degree, the element of nervous apprehension being more marked in some than in others.

On the return of sensation, the patient often complains of a headache, which is seldom persistent or severe, and generally yields to a small dose of aspirin. Vomiting occasionally occurs, but is not prolonged. The temperature is nearly always raised to 100° F. for forty-eight hours, when it returns to normal. Later sequelæ have been reported, such as paralysis of the ocular muscles and paraplegia, but one cannot avoid the conclusion that such were due to a faulty technic.

The stovain-glucose solution, recommended by Barker, and now used by him and others for five years, is made by Billon, 92 Rue Vieille du Temple, Paris. It is issued in glass ampoules, each containing about 2 c.c. of a 5 per cent. solution of stovain and 5 per cent. of glucose. The filled ampoules are carefully sterilized at 110° C. before being finally sealed.

One cubic centimeter of this solution containing, as it does, 5 centigrams of stovain, usually produces analgesia in two to ten minutes, which lasts from fifty to sixty-five minutes at the level of the umbilicus. For a more protracted operation, 1.2 c.c. of this solution, or 6 centigrams of stovain, may be injected.

LIMITATIONS.

During the first experimental years after its introduction spinal analgesia was undoubtedly employed in many places much too extensively. It was used by many who, while appreciating its possibilities, yet lacked a knowledge of its limitations. This led to accidents and disasters in its use which were discouraging to its thoughtful pioneers. With greater experience, however, and in the hands of careful workers, spinal analgesia is now recognized as a useful and safe method, by means of which operations on the lower half of the body may be painlessly performed.

A high injection of stovain, combined with strychnin, has been used by Jonnesco for operations on the head and upper extremities, which in his hands has met with some success, but in not a few cases very dangerous symptoms have developed and some deaths have

occurred. This method has not recommended itself to surgeons in Great Britain and America.

Nevertheless, if spinal analgesia be only found safe and of value for operations below the xiphisternum, much has been gained to surgery.

Age and sex offer no bar to this procedure; it is as suitable for women as for men.

Rood, following Barker's technic, uses spinal analgesia as the anesthetic of choice for nearly all operations on children, and finds that it is especially indicated in acute abdominal cases, where it gives most complete relaxation of the abdominal muscles and reduces shock to a minimum.

There are dangers, however, in the use of this method which should on no account be overlooked. The possibility of infecting the spinal sac with septic organisms is always present. No one should attempt this procedure whose aseptic technic is not above suspicion; such a danger is minimized by the simplicity of the apparatus required and the bactericidal properties of stovain. The amounts of the drugs suitable for injection are now determined, so an overdose should be impossible.

Should the injection fluid run as high as the cervical region there is considerable danger of paralysis of the phrenic nerve in addition to the intercostals. This would mean loss of respiratory power, and consequent death, unless the condition were promptly recognized and successfully combated by artificial respiration, especially by the Meltzer-Auer method (page 968), until the paresis passed away. Such an accident should not occur if the patient's head and neck are carefully raised, and kept elevated from the moment of injection until sensation returns in the feet.

For beginners it is inadvisable to use this method in debilitated patients for severe operations on the abdomen requiring high analgesia, though, with experience, it may be used as a routine for all operations on regions below the umbilicus, and in many cases for operations on the stomach, liver, and kidneys.

The realization that a painless operation can be performed without loss of consciousness comes as a boon to many patients, and, though others prefer to "know nothing of what is happening," the majority of those who have had both a general and a spinal anesthetic state their preference for the latter.

CHAPTER CLIII.

SURGERY OF THE INFECTIOUS DISEASES.*

By George E. Armstrong, M. D.,

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Typhoid Fever.—Since Vol. V. was published the advances in the surgery of many of the infectious diseases have been considerable, and in none, unless it be that of pulmonary gangrene and abscess, has it been greater than in some of the surgical complications of typhoid fever.

Each year there is a lowering of the mortality from perforation of the bowel, due to greater alertness on the part of the physicians, and especially the resident medical officers in the large hospitals, earlier diagnosis, and improved technic. Exploratory incision under local anesthesia in doubtful cases is recognized as a conservative act. One need not wait until the diagnosis is established by the presence of a more or less generalized peritonitis. Pain, vomiting, and localized or general abdominal tenderness, with increased resistance, demand careful watching, and, if not soon relieved by other means, the abdomen should be opened and the cause searched for. In the Montreal General Hospital during the year 1909 and up to May, 1910, there occurred 22 perforations, 19 of which were operated upon and 9, or 47 per cent., recovered. It may be at once conceded that early operations are attended by a percentage of error in diagnosis, sometimes fortunate, seldom harmful.

Instead of the suspected perforation we may find an intussusception, as in the 2 cases reported by Smith.[21] In one, a boy seventeen years of age, symptoms of perforation developed on the twenty-sixth day. Intestinal hemorrhage had occurred twice. Instead of a perforation there was found, 3 feet below the junction of the duodenum and the jejunum, an intussusception 2½ or 3 inches long. It was readily reduced and the boy recovered, although he had, after the operation, two more hemorrhages of 120 and 500 c.c. respectively. In his other case, a female aged twenty, an ileocolic intussusception of 4 to 6 cm. was associated with mesenteric thrombosis. Two large thrombi were removed, the intussusception reduced, and the lower end of the ileum stitched to the peritoneal wound. The patient recovered. Smith collected 9 other cases of intussusception that had occurred during typhoid; 3 were discovered at autopsy; 5 were operated upon, with 4 recoveries and 1 death. In 1 the result is not stated.

Roberts[18] reports a case of volvulus of the small intestine occurring in a girl nineteen years of age which he relieved by operation, followed by recovery. Eustis[6] reports 2 cases in which the volvulus was discovered

* Supplementary to Chapter LXXXII., Vol. V., p. 1101.

at autopsy. In the cases of intussusception the diagnosis was perforation, and operation was undertaken to close the opening. There was an error in diagnosis, but the operations saved 7 lives that would otherwise have been lost. In many cases it is impossible to differentiate between perforation, intussusception, volvulus, or strangulated Meckel's diverticulum, as in Sailer and Frazier's[20] case, or acute intestinal obstruction by bands, as in Goodall's[7] cases. Indeed, in one of Goodall's cases, a perforation in a male twenty-two years of age was recognized and closed. No bands were present at this time, although three weeks later, when a second perforation occurred and caused the death of the patient, a number of small bands were found at autopsy producing kinks and compression of the small intestine. In his other case, a boy fourteen years of age, the obstruction occurred during the second relapse. The boy complained of pain, hiccups, and vomiting, and died rather suddenly. At the autopsy the small intestine was partly obstructed $2\frac{1}{2}$ feet above the ileocecal valve by a fibrous band stretching from the mesentery to a point on the small intestine. Apparently the band had developed from a patch of localized peritonitis situated opposite a deep typhoid ulcer. These cases, together with Young's case reported in Vol. V., of obstruction of the lower 22 inches of the ileum two and a half years after an attack of typhoid fever and due to bands in the submucous tissue, believed to be due to an old typhoid ulceration, show that the presence of typhoid or a history of typhoid must be considered in the presence of either acute or chronic intestinal obstruction. One may not be able to differentiate the above condition from a perforation or from a suppurating mesenteric gland, a ruptured gall-bladder or spleen, but the truly conservative man will open the abdomen and deal with what he finds. The great value of more frequent consultation between physicians and surgeons in typhoid and other border-line diseases is becoming more and more keenly appreciated.

Intestinal Hemorrhage During Typhoid Fever.—The frequency of intestinal hemorrhage during typhoid fever varies with epidemics, as does perforation. McCrae[14] analyzed over 23,000 cases and found 7 per cent. a fair average. He also noted that some families seemed more prone to bleed than others. Harte,[8] after studying the statistics of the Pennsylvania Hospital, concluded that hemorrhage is the most fatal complication of typhoid except perforation. It is not common in children under ten years of age. Barrett[2] reports the case of a child three and a half years old that passed 1000 c.c. of bright blood on the fifth day of obvious symptoms. The child recovered. Harte[8] operated on 2 cases with the distinct object of arresting hemorrhage. In the first one, a male thirty-two years of age, the bleeding had continued for six days in spite of the usual remedial measures. A small perforation was also found. The man was in a desperate condition, and, although his bleeding was controlled, he failed to rally. In the second case, in addition to the hemorrhage, there were three perforations. The man died. Harte thinks that surgeons should interfere to control bleeding from a typhoid ulcer as in other cases of concealed hemorrhage, such as a gunshot or

stab-wound of the abdomen or a ruptured ectopic pregnancy. He states that where no associated perforation exists the bleeding-point may readily be found by holding the gut before an electric light. The bleeding may be stopped by a suture passed through the peritoneal to the mucous coat, transfixing the bleeding vessel and bunching it up, or massing the serous coat and fortifying that special point, so that it is less liable to perforate in the near future if the ulceration still advances. If coming from several points, the gut might be opened and packed with gauze around a flexible tube and an artificial anus established, which could be closed without difficulty later.

Esophageal Stricture from Typhoid.—Thompson[22] reports 3 cases of esophageal stricture and appends reports of 9 others. In 5 of these cases much benefit was derived from gradual dilatation. In 2 cases gastrectomy with retrograde dilatation gave relief. In 2 cases gastrectomy alone was performed, and 3 died of starvation, refusing operation. Louis[13] found lesions in the esophagus in 7 out of 46 autopsies; Holscher, 1 in 2000 autopsies. Louis says that when few in number the ulcers are confined to the region of the cardia or the middle part of the tube. No cases of perforation have been reported. He thinks the ulcers are due to the extreme malnutrition of the tissues rather than to typhoid infection, and when situated in the lower end of the tube are the result of peptic digestion of the esophageal mucosa. It is a little remarkable that all the cases of esophageal stricture, with one exception, have been in males.

Spontaneous Rupture of the Spleen in Typhoid.—Craig[4] reports the spontaneous rupture of the spleen, without abscess, about the thirty-fifth day of typhoid in a young man twenty-three years of age. The blood was examined and found negative for malaria. There was found at the autopsy a large laceration through the capsule at the lower portion, measuring about 3 cm. in length. There was considerable laceration of the splenic substance. The surface, on section, was of a dark mahogany-red color, the Malpighian corpuscles being indistinct. The spleen was greatly congested and the laceration extended for a distance of 1 cm. into the substance of the organ. Cultures made from the spleen gave a pure growth of the typhoid bacillus. There were evidences of the blood becoming encapsulated by a localizing peritonitis, due to the irritation of the blood or to bacterial infection from the intestines. Several of the ulcers were simply separated from the abdominal cavity by the exceedingly thin serous coat of the intestines. West and Dudding[23] report a similar case occurring in a soldier. The severe abdominal pain, vomiting, subnormal temperature, and the absence of liver dulness suggested perforation. The abdomen was opened and found filled with blood. No perforation was discovered. The man died soon afterward, and at the autopsy the spleen was found ruptured for the extent of 3 inches on its diaphragmatic surface. It weighed 2 pounds, $2\frac{1}{2}$ ounces, and its capsule was extensively separated by the clot. In the small intestine were seven typhoid ulcers, and in the cecum one very large and deep ulcer. The mesenteric glands were much enlarged.

Typhoid Joints.—Joint affections developing in the course of typhoid are not common. They do not occur with anything like the frequency of bone infections, yet they are of great interest, more especially because of the large percentage of dislocations that follow. Ardisson[1] found that 33 of the 84 spontaneous dislocations of the hip reported occurred during typhoid fever. Ellis'[5] experimental study of joint affections induced by the typhoid bacillus throws some light on the rather obscure pathology of this complication. He found that a pure culture of typhoid bacilli injected into a joint produced a serous seropurulent or purulent exudate. He established quite clearly that typhoid bacilli in a joint are pyogenic and capable of "severely damaging and even destroying the various elements entering into the formation of joints. Collectively, all the component parts of those structures, synovial membrane, interarticular ligaments, semilunar cartilages, articular cartilages, bone, the joint capsule, and the surrounding tissues, including the muscles, were thus affected." As Ellis remarks, one must reservedly accept these findings as definite indications of the change in typhoid joint affections in human beings. But few opportunities have offered for the pathologic study of typhoid joints because the patients have generally recovered. These studies throw light on the pathology of spontaneous dislocation only in so far as it is favored by the destruction of the component part of the joint. Rawden[17] operated on a little girl eight years of age for spontaneous dislocation of the hip during typhoid. The head showed no notable absorption. The synovial membrane was not demonstrable. The cartilage in general was intact, showing only a little absorption around the circumference at its junction with the neck. The bony structure of the head and neck were absolutely normal and the surrounding tissues were notably healthy. In Hubener's[10] case, a girl of fourteen years, the head of the femur was loose at the epiphyseal line, the acetabulum was empty and covered by slight masses of granulation tissue. The head of the femur was free and lay behind and above the acetabulum, embedded in a moderate amount of granulation tissue. It is probable that distention of the capsule plays an important part in spontaneous dislocation.

Typhoid Gangrene of the Extremities.—There is, perhaps, comparatively little to be added to the remarks made in the System, but the following case is of interest from the fact that the gangrene appeared first in the right leg and later in the left. The patient was a woman fifty years of age. Dr. Wolbach, at that time pathologist to the Montreal General Hospital, made a careful report on the vessels. The right leg showed discoloration on the twentieth day of the disease, due to thrombosis of the popliteal artery. Six days later pulsation could not be felt in the common femoral. The leg was amputated above the knee on the twelfth day after discoloration appeared. Three days later the left leg became discolored and cold. At the autopsy there was found a large grayish-red plug which extended about 3 cm. above the bifurcation of the aorta and occupied the whole lumen. Following the plug down, the common and external iliacs were found completely filled with it. The right femoral was thrombosed to just below Poupart's ligament, where it

had been ligated at the time of operation. On the left side the popliteal was normal and also the femoral, save for a thrombus about 4 cm. long, placed just below Poupart's ligament. The thrombus was distinctly adherent to the arterial wall. The aorta was absolutely normal, save for a few small atheromatous patches. The heart was about normal in size. The myocardium was of a bright red color and of good consistency. The valves and coronary arteries were normal. The lungs were small and deeply pigmented, the base firmer than normal, and the apices slightly puckered. Small calcareous deposits were seen in each apex. The bronchial glands contained small calcareous deposits.

Further evidence of the diffusion of the typhoid bacillus is found in the infection of tissues not usually involved.

Typhoid Strumitis.—Krause[11] reports an interesting instance of typhoid infection of the thyroid gland in a young man twenty-three years of age, suffering at the time from typhoid fever. Thyroid enlargement had been present since childhood. About the end of the fourth week the thyroid began to increase in size. It became painful and tender. Ice was applied locally, but the enlargement continued and the overlying skin became red and hot. Fluctuation being clearly established, a puncture was made and pus withdrawn, which gave a pure culture of the typhoid bacillus. There are 5 similar cases on record.

Suppurating posttyphoid mammitis is reported by Roger.[19] The patient, thirty-five years of age, had had typhoid when six years old. A year before she came under his observation, while nursing a child, she had had symptoms of typhoid, consisting of fever with intestinal hemorrhages, myocarditis, and dyspnea of bulbal origin. During convalescence there appeared a tumefaction of the left breast, accompanied by axillary adenitis and ending in suppuration. From the pus a bacillus was isolated which was neither the colon bacillus nor Eberth's bacillus. It may have been a paratyphoid organism. The author found reports of 23 cases. In 1 of these the affection was bilateral, in 1 it coexisted with thyroiditis. Out of the 24 cases only 10 suppurated. The affection occurs during the decline of the disease, less frequently during convalescence or when the patient is well. Cure is said to be rapid after incision.

Purulent Meningitis in Typhoid.—There have been reported 14 or 15 cases of purulent meningitis due to the typhoid bacillus. Lavenson's[12] case is particularly interesting from the fact that there were no other lesions of typhoid, no intestinal ulcers, or enlargement of the spleen. The Widal reaction was absent on the fifth day and present on the eighth day. The patient, a woman twenty-six years of age, was supposed to have had typhoid several years before. For several weeks immediately prior to her illness she had nursed a brother suffering from typhoid. Lavenson intimates that Henry and Rosenberger have also had a case of purulent meningitis without intestinal lesion. In each case the typhoid bacillus was found in the cerebrospinal fluid. Headache, vomiting, muscular rigidity, and stupor have been prominent symptoms. Kernig's sign was generally present. In Lavenson's case there were two collections of pus over the vertex, one on each side. The base was free.

Ovarian cysts in typhoid have not altogether escaped the bacillus of typhoid. At least 38 cases have been reported as giving a pure culture of the typhoid bacillus. Coe[3] draws attention to the fact that in almost every instance the cyst was a dermoid. This would seem to show that sebaceous material forms a more favorable medium for the development of the typhoid bacilli. The cases cited by Lewis and LeConte are interesting because the operation for their removal was immediately followed by a relapse of the typhoid. The prognosis after removal is good.

Surgical Diseases Caused by the Pneumococcus.—Empyema.—(See Vol. III., p. 530.)

Abscess and Gangrene of the Lung.—Pulmonary gangrene and abscess, although recognized by Hippocrates and considered by various writers from that time up to the present, has become of practical interest to the surgeon chiefly since the era of Listerism. Indeed, it is only within the last few years that the surgery of the lungs, including pulmonary gangrene and abscess, has received serious attention and been placed upon a sound scientific basis. The various details connected with the diagnosis, operative treatment, and prognosis of these conditions have been advanced very largely by the labors of Quincke, Tuffier, Gluck, Karewski, Garrè, and Körte.

Pulmonary abscess and gangrene occur frequently in epileptics and alcoholics, and are often secondary to a pneumonia, especially an aspiration-pneumonia. They have followed the extraction of a tooth under general anesthesia, an alveolar abscess being present; and are sometimes embolic, as when occurring after confinement. They may follow traumatic pneumonia.

The diagnosis and location of pulmonary abscess is sometimes extremely difficult, and differentiation between abscess and gangrene is, in many instances, quite impossible. Lenhartz and Körte think the differentiation artificial and uncertain. In both lesions the primary condition is infiltration and smelting together of the tissues, and whether these tissues break down and form large sequestra, or break down into small particles, often as elastic tissue, is only a question of degree. In fact, it is difficult and sometimes impossible to tell whether there is a sequestrum or not. The differentiation by examination of the sputum may lead to erroneous conclusions, for although a purely purulent expectoration would stand for abscess, and a fetid ichorous expectoration for gangrene, yet a sequestrum may be present with a purely purulent expectoration. In one of Körte's cases, ten days after the opening of the abscess-cavity in the lung a sequestrum the size of the end of the thumb was removed. In fact, abscess and gangrene may both obtain in the same cavity. The prognosis would seem to be better in cases of pure odorless pus.

Foul-smelling purulent sputum containing lung tissue or elastic tissue indicates the presence of pulmonary abscess or gangrene, or both. Traces of blood are frequent and hemorrhages are not uncommon. If putrid sputum follows acute lung disease, three things are possible: abscess or gangrene, bronchiectatic cavities, or a bursting of pus into the lung from the pleura, subphrenic region, or the mediastinum. In

the differentiation of these three conditions a careful study must be made of the history of the cases as well as a careful physical examination.

A thin layer of normal lung tissue over the cavity will completely mask the condition. Fluoroscopic and *x*-ray examinations are most valuable aids in these cases, and will often show the location of the cavity when physical signs and other methods of examination fail. They may also show how deep or how far removed from the surface of the lung is the abscess. For instance, the physical signs may indicate that the abscess is at a certain level, but a fluoroscopic examination may show clearly that the cavity extends downward and that its lower end is farther removed from the surface of the lung than the upper end. This knowledge may prove most valuable to the surgeon, showing him where to place his incision to secure the best drainage for the cavity.

The diagnosis of bronchiectatic lesions by the fluoroscope is much more uncertain. As remarked by Pfeiffer,[16] the similarity of the symptoms of bronchiectasis when accompanied by fetid bronchitis to those of lung gangrene and abscess, is very close, and the difficulty in differentiating between the two is extremely great. In bronchiectasis the condition, of course, is generally more widespread and diffused over one or more lobes in one or both lungs.

The use of the exploring needle as a diagnostic measure is inadvisable, because of the danger that the two layers of the pleura may not be adherent. The pleural cavity may then become infected and a septic empyema develop. There is also the danger from puncturing vessels and hemorrhage. I have known hemorrhage to be quite smart, although never fatal, after the use of the exploring needle. Even if the pleural layers are adherent, infection may pass into the overlying tissues of the chest wall and give rise to a phlegmonous inflammation.

The interesting relationship of bronchiectasis to pulmonary abscess is, however, not alone in the question of differential diagnosis. Bronchiectatic conditions have been known to develop in the neighborhood of a healed pulmonary abscess as a result of shrinking of the scar tissues and dilatation of the adjacent bronchi. Such cases have been reported by Garrè and Helferich-Lichtenauer.[9] Körte also reports a similar case upon which he operated for acute abscess of the right lung. A month after the cavity had healed the patient returned, suffering from a recurrence of putrid expectoration. Seven months and a half after the first operation an incision was made through the scar and a system of dilated bronchi was found. He reports further 3 other cases of acute gangrene of the lung, where, in the region of the cavities at autopsy, there was found a beginning dilatation of the bronchi where no healing process was apparent. Körte admits that there may have been in these cases a pre-existing bronchial dilatation which favored the development of the gangrenous process.

Patients sometimes seem to develop gangrene without a pre-existing pneumonia or pulmonary abscess. Emboli may arise from a puerperal infection, retrocecal and appendicecal abscess. Embolic abscesses are frequently multiple, and in that case are not adapted to surgical treat-

ment. In one, inspiration of water while bathing was a cause. Typhoid fever, measles, facial erysipelas, and bronchitis may be etiologic factors; in one, tropical dysentery and hepatic abscess. In acute cases the abscesses are generally solitary.

When the diagnosis is made and the cavity located it is unwise to delay operation because of the danger of hemorrhage, extension of the disease in the lung, bursting into the pleura, and the occurrence of metastasis and sepsis.

Reasons which justify delay in operation are persistence of the acute pneumonic process and the desirability of having firm adhesions between the two pleural layers. These, however, should not be allowed to weigh against early evacuation of the pus when there are well-marked indications for the same.

In the early stages the abscess walls surrounding the tissue are softer and more yielding than they are later on.

In chronic abscess the conditions of healing are much less favorable, as the walls are hard and unyielding. To bring a chronic abscess to healing generally requires extensive resection of ribs and often of the thickened visceral pleura as well.

While it cannot be denied that certain cases recover after rupture of the abscess into a bronchus, yet experience has shown that this is an uncertain result, and that the mortality in unoperated cases is very much larger than in operated cases. In diffuse bronchiectasis the conditions are quite different, the disease is not so localized, operation is not so satisfactory, and the prognosis is not so good. The drainage of localized bronchial dilatations is sometimes successful.

Resection of a whole lobe has sometimes been found necessary, and is sometimes followed by success. The operation, as a rule, is undertaken for the relief of abscess or gangrene.

Operations for the relief of large hemorrhages are not easy. There is the difficulty of coming directly upon the bleeding-point and the danger of the patient bleeding severely into the bronchial tubes while the operation is going on. If one is sure there is only one abscess from which the bleeding comes, and if the physical signs and fluoroscopic examination shows that the abscess is superficial and the patient's life is jeopardized by the recurrence of large hemorrhages, one might be justified in such instances in opening the cavity with a view to controlling the hemorrhage by ligature or by packing. If the cavities are multiple, or if the condition is one of bronchiectasis, operation is cerainly contraindicated.

Nordmann[15] draws attention to the possibility of hemorrhage occurring in cases of pulmonary gangrene, and to the small mention of this complication in books. Laennec and Trousseau do not mention it at all. Grisolle, Eichhorst, and Nothnagel simply refer to it. Hardy and Beheir, on the contrary, clearly indicate its importance and gravity. It must be divided into two forms: the small capillary hemorrhages which are sufficiently frequent, and the grave hemorrhages due to rupture of large vessels and which are generally fatal. In some instances there may

be some preparation made before operating. Only too often, however, patients are brought to the hospital in a desperate condition and require immediate relief. When possible, these patients should be prepared in the usual way for the operation, with the added special precaution to get them to cough up as much as possible before hand. Many of them know what position to assume to accomplish this end. They know that by turning on one side or the other, by lying on the back, or on the face, or hanging the head low, they can empty out a large quantity of matter, which renders the subsequent operation much safer.

After portions of one or two ribs are resected over the cavity, the next question is, Are the layers of the pleura smelted together and adherent? Tuffier reports 215 cases in which the pleura was adherent in 190, or 95 per cent. It is not always easy to decide this point. Putting in a needle, and expecting it to be moved up and down if the pleural surfaces are not adherent, is an uncertain test, because it is almost impossible to stop the point of the needle just where it pierces the visceral pleura, and if it goes much further the lung tissues move it up and down. I have usually found that if the parietal pleura was thickened, adhesions were present. If in doubt, and the patient's condition permits, one may suture the two layers together, as recommended by Péan, Tuffier, and Roux. In suturing the pleural layers, round needles are preferable, and Garrè recommends inserting them during expiration and covering the pleura with the finger during inspiration. I have never known any infection to occur from this operation. If the condition is urgent, incision may be made at once and the lung entered, but it is safer to wait a couple of days for adhesions to take place. In other cases, when in doubt, the application of the cautery or simply packing the wound with iodoform gauze will be followed by the union of the pleural surfaces in forty-eight or seventy-two hours. Suture, however, is the procedure of choice.

Incision through the lung tissue into the abscess-cavity may be made in several ways. In some cases, where the tissue is hard and dense, particularly if the fluoroscopic examination has shown the abscess wall to be near the periphery of the lung, one may enter simply by blunt dissection, and when entrance into the abscess-cavity is demonstrated by a flow of pus, pass a pair of narrow-bladed forceps along the groove of the director, and by separating and withdrawing the blades secure an opening sufficiently large to permit the introduction of a finger for purposes of exploration. This is a valuable detail, as it enables one to determine the size and direction of the cavity and the location of any communication with a bronchial tube. If there is much lung tissue to pass through in reaching the cavity, a thermocautery or electric cautery enables one to enter with comparatively little loss of blood. An incision, however, may be made if good access has been obtained previously, and any bleeding points caught and ligated.

The after-treatment consists in providing free drainage and easy emptying of the cavity. This is generally accomplished by the insertion of a soft-rubber tube. At the time of the operation the cavity may be

wiped out with gauze swabs, and sometimes a considerable mass of gangrenous tissue and shreds are wiped away in this way without causing hemorrhage. Later, during the period of granulation, healing may be promoted by packing with gauze and by using tincture of iodin, nitrate of silver, or balsam of Peru.

The incision of the tissues of the chest wall must not be allowed to close until the lung cavity is healed. Small hemorrhages are not infrequent before operation, as has already been mentioned, and hemorrhages of considerable quantity sometimes follow the use of the exploring needle. Hemorrhages after operation and after the cavity is opened sometimes occur, and, if severe, the cavity should be packed with gauze.

Permanent fistula is rare and may be said not to occur in those cases in which the two pleural layers were adherent at the time of operation. If, however, before drainage is established the abscess or cavity has burst into the pleura before the pleural layers were adherent, then the same rules for healing may apply as for empyema. The visceral layer may become so thick as seriously to retard the expansion of the lung and the healing cavity. The cavity seems to close generally by granulation and scar tissue, gradually contracting and obliterating the opening. During the process, as has already been mentioned, the bronchial tubes in the neighborhood may become stretched and dilated.

Surgery of the Puerperium.—The suggestions contained in Vol. V. regarding surgical relief of renal insufficiency have been disappointing. Nephrotomy or decortication may in exceptional cases prove of service in eclampsia, but only in that class where anuria is present. The present view is that eclampsia is not so generally due to changes in the kidneys as formerly thought, but rather to gastro-enteric conditions, and especially to diminished and faulty action of the liver. The surgeon is frequently consulted regarding urgent minor and major operations during pregnancy. Each case must be considered on its merits. The earlier in the period of gestation that an operation is undertaken the safer, and the less the likelihood of premature labor following. The condition of the mother is all important. If the gastro-intestinal functions are being normally performed, and the specific gravity of the urine is normal, which may be taken to indicate that the specific gravity of the blood-serum is normal, operation may be performed without much danger of interrupting gestation. Keen performed an amputation of the hip-joint for sarcoma of the femur, the patient being at the time five months' pregnant. Gestation proceeded quite normally to full term. My own experience was not so fortunate. I performed an interscapulo-thoracic amputation for a rapidly growing sarcoma in a woman six months' pregnant. There was very little loss of blood or apparent shock, but gestation was interrupted on the third day after the amputation. The woman made a very satisfactory recovery.

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CHAPTER CLIV.

THE *X*-RAY IN SURGERY.[1]

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An effort was made in the chapter on the *x*-ray in the previous edition (Vol. V., p. 1143) to give an idea of the essential qualities of the Röntgen ray, and to point out some of the most common pitfalls which are met by the surgeon who is unfamiliar with the intrepretation of radiographs.[2] The more important uses of this agent were then mentioned, and brief remarks made on each of these uses in proportion to its relative value. On reviewing this chapter I find no statement of fact which has to be withdrawn, although through the necessities of space many important points, as well as others of great interest and promise, were passed over with little comment.

In the present brief chapter I will enumerate the practical uses to which the *x*-ray is now put. Fortunately, in other parts of the volume—in fact, in almost every part of the volume—references with appropriate illustrations will be found to the use of the *x*-ray in connection with each subject. Here I must at least register a protest against the scanty space which the science of röntgenology receives, not only in the text-books, but in its share of the students' time in modern medical education, and in its proportion of the expenditure and equipment in large hospitals. The breadth and importance of this science is not generally recognized. The dignity and standing of the physicians directing the *x*-ray departments of hospitals should be on a par with the heads of other clinical departments. The mere fact that the *x*-ray apparatus can be operated by an uneducated person with apparently good results should not deceive us into thinking that the interpretation of the pictures can be as easily accomplished. The accompanying table of the uses of the *x*-ray gives a good idea of the many points of contact which röntgenology has with the sciences of medicine and surgery. When we consider that the data furnished by the *x*-ray are *always accurate* and that the interpretation *only* offers a chance for error, we realize the importance of looking for the interpretation from a person whose fundamental knowledge of anatomy, physiology, pathology, and clinical medicine is of the best. An *x*-ray picture is always an accurate chart of the atomic weights met by the absolutely undeviating rays in their mathematically correct paths from the focus-point. As the light emerges from a single point, the chart is

[1] Supplementary to Chapter LXXXIII., Vol. V., p. 1143.

[2] In the previous chapter the word "skiagraph" was used, but as the use of the word "radiograph" has become general, I adopt it here.

registered according to the laws of projection. The resulting radiograph is, in reality, one of the simplest and most absolute of clinical tests. When errors are made in interpretation, they are wholly due to the ignorance or defective logic of the interpreter. The röntgenologist must not only know surgical anatomy and physiology, but *x*-ray anatomy and *x*-ray physiology as well. For instance, the actual size and shape of the stomach, as known to pre-Röntgen anatomists, or its motor function and peristaltic activity, as known to pre-Röntgen physiologists, were almost as inaccurate as the map of Europe before Columbus proved the earth was spherical. The röntgenologist who has repeatedly watched the behavior of a bismuth meal in its passage through the alimentary canal has a far more accurate idea of the normal processes of digestion than had the best pre-Röntgen clinician. Röntgenology has become a legitimate specialty, *i. e.*, a branch of the science of medicine a knowledge of which sufficiently thorough to justify practice requires more time than can be accorded to it by the general practitioner. The remaining portion of this chapter will, therefore, be devoted to enumerating, and briefly commenting on, the different contingencies in which the surgeon must or may ask help from the röntgenologist.

USES OF THE *X*-RAY.

The following table, showing the points of contact of röntgenology with general surgery, is presented for three purposes:

1. To make evident the discrepancy which exists to-day between the practical importance of the *x*-ray and the attention accorded to it by the surgical text-books, the medical schools, and the hospitals.

2. To give to the student and practitioner an opportunity to see in what classes of cases they should utilize the aid of the *x*-ray for their patients. The conditions for which the *x*-ray *should* be used are printed in italics; those for which it *may* be used, in ordinary type.

3. To introduce the remaining text, which consists of brief remarks on some of these subjects, the choice being made more because of special development in the application of the Röntgen ray to these fields during the last five years than because of their relative practical importance.

Foreign bodies *in any part of the body; indispensable for those in: Eye, brain, esophagus, stomach, intestines, bronchi, bladder.*

Fractures of: *Cranium,* bones of face, *lower jaw,* vertebræ, clavicle, sternum, ribs, scapula, *humerus, radius, ulna, carpal bones,* metacarpal bones, *phalanges, ilium, ischium, pubes, femur, tibia, fibula, tarsal bones,* metatarsal bones, *phalanges.*

Dislocations *of the joints formed by the above bones.*

Diseases of bone: The following diseases may affect any of the above bones: *Syphilis, tuberculosis,* leprosy, *metastatic cancer, multiple myeloma, sarcoma of various types, bone cyst, chondroma, osteoma, osteomyelitis,* acute bone atrophy, *caries,* rickets, scurvy, Paget's disease, *Von Recklinghausen's disease, osteomalacia,* acromegaly, *osteoporosis,* chondrodystrophy, *fragilitas ossium,* etc.

Orthopedic cases *in which deformity has resulted from any of these fractures or diseases, as well as those resulting from: Congenital conditions, abnormal growth, hypertrophic arthritis, infectious arthritis, suppurative arthritis, rheumatism, abnormal positions,* etc.

Esophageal cases: *Impacted foreign bodies, cardiospasm, diverticula, strictures.*

Diseases of stomach: Ptosis, atony, pyloroptosis, *hour-glass stomach, either functional* (spasmodic) *or organic, penetrating ulcer, obstructive hypertrophy, whether compensated or uncompensated.*

Diseases of small intestine: *Duodenal stasis, Lane's kink,* obstruction by adhesions or tumors.

Diseases of large intestine: Ptosis, *kinks of flexures, prolapsed cecum, megacolon, different forms of constipation,* malignant strictures (hypermotility), diverticulitis, *dyschezia.*

Diseases in thorax: Tuberculosis of lungs, tuberculosis of bronchial lymph-nodes, tuberculous cavities, *abscess of lung, bronchiectasis,* emphysema, pleuritis, pleural effusion, empyema, *pneumothorax, mediastinal tumors, aneurysm, subphrenic abscess,* limitation of diaphragm, *hernia of diaphragm, metastases in lung.*

Diseases of kidneys: *Size, shape, and presence of kidneys, stone and its position in kidney or ureter, strictures of ureter, dilatations of ureter or renal pelvis* (by collargol), *caseous kidney, tumors of kidney, double ureter, malpositions of ureter.*

Diseases of bladder: Stone, diverticula.

Unclassified conditions: *Myositis ossificans,* tabes mesenterica, *subacromial bursitis,* calculi in salivary glands or testes, *tumors of brain,* hepaptosia, *hyperostosis cranii, loose bodies in the knee* and other joints, empyema and tumors of *accessory sinuses,* arteriosclerosis, ainhum.

Dentistry: *Unerupted teeth, lost roots, roots in floor of antrum,* etc.

Therapeutic uses: *Eczema, pruritus, psoriasis, sycosis,* etc. *Epithelioma and rodent ulcer, lupus and scrofuloderma, keloid, inoperable cancer and sarcoma,* exophthalmic goiter, Hodgkin's disease, cervical adenitis, etc.

Use in research: It has made possible the work of *Cannon,* on the physiology of the digestive system; of *Boehm,* on lateral curvature; of *Dwight,* on accessory bones; of *Rotch,* on the appearance of epiphyses; of *Hertz,* on constipation, and has contributed to the true knowledge of nearly every lesion mentioned above.

Foreign Bodies.—(See Chapter LXXXIII., Vol. V., p. 1153.)

Fractures.—It should be a general rule in cases of fracture of important bones to place the responsibility of *not* having a radiograph on the patient or his family. No surgeon's diagnosis of a fracture is so sure that he can afford to neglect having an *x*-ray picture taken except for excellent reasons. I have seen within the last year several cases in which the neglect of this precaution by experienced surgeons has been a cause of great regret. Even in cases of "sprains," where there is neither crepitus nor abnormal mobility, and where localized swelling and tenderness are the only signs of a lesion, a radiograph will often show a fracture. Particu-

larly is this true when ecchymosis is present below the seat of tenderness. This is as sure a sign of the presence of fracture as crepitus. When such lesions are about the joints an early diagnosis is particularly important, because intracapsular fractures, in which synovial fluid flows freely between the fragments, are especially slow to unite. Such fractures are the separations of the anatomic necks of the humerus and femur, fracture of the carpal scaphoid, and the posterior facet of the astragalus.

Radiographs should always be taken before operation in cases of injuries to the skull where this is practical, as in large hospitals. Surgeons will find much help in making this a routine. Fractures of the skull are usually much more extensive than appears at operation, and in good *x*-ray pictures one is surprised to see numerous fissures extending even into the base. Many cases which pass as "concussion" have these fissure fractures. In crushing injuries of the pelvis or in obscure injuries to the hip a good radiograph of the pelvis may show fracture of the acetabulum or ilium close to the sacro-iliac synchondrosis. Such lesions tend to reduce themselves immediately after they occur.

In almost all fractures a radiograph is more important after reduction than before.

Dislocations should always be radiographed, even if they have already been successfully reduced. They are apt to be complicated by small separations of bits of adjacent bone which may interfere with convalescence. For instance, fracture of the head of the radius frequently complicates dislocation of the elbow, and separation of the tuberosity of the humerus frequently complicates dislocation of the shoulder. Fractures of the phalanges of the fingers are not too insignificant to demand a radiograph—they may prove to be dislocations.

Bone-diseases.—(See Vol. V., p. 1156, and Fortschritte Supplement.)

Orthopedic Cases.—The use of *x*-rays has become indispensable in orthopedics, not only in aiding in the diagnosis of the various deformities which are within the province of orthopedic surgery, but as a check to the different devices which are used to correct these deformities, whether they be in the form of apparatus or splints, or in internal appliances, such as ivory pegs and bone-plates, screws, and nails.

The *x*-ray has materially advanced our knowledge of diseases of bones and joints, and has served to illustrate many papers on these subjects. Even the vertebral joints, the lumbosacral articulation, the sacro-iliac synchondroses, are shown well in modern *x*-ray pictures.

Esophageal Surgery.—The reader is referred to the work of Plummer in the Trans. Amer. Med. Assoc., June, 1910. Although cardiospasms and diverticula can be diagnosed with a fair degree of certainty without the *x*-ray, it is nevertheless the most direct method of diagnosis, and far the most convenient to both patient and physician. In esophageal cases the use of the fluorescent screen is important as well as that of the radiograph. In the normal esophagus there is no peristalsis visible, the descent of the food through the passage being dependent more on the quality of the substance swallowed than on the peristaltic activity. Thus, fluids

pass very quickly, while substances of a viscid and sticky consistency are seen to descend more slowly. If the fluorescent screen shows an accumulation of food in the esophagus and at the same time a decided peristalsis or an up-and-down movement like a piston, the diagnosis of stricture at the cardiac orifice can be made.

It is probable that within the next few years we shall see a still greater advance in the radiographic technic in diseases of the esophagus, because there are already several very promising methods of diagnosis which are not yet well enough substantiated to become the property of the general profession.

Diseases of the Stomach.—It cannot be said at present that the use of the *x*-ray has more than a potential importance in the diagnosis of disease of the stomach. The studies of Cannon, on the motor functions of the stomach and intestinal tract in the lower animals, revolutionized the previous conceptions of this subject. Rieder, soon after Cannon's publications, began a similar work on the human being, and Rieder's bismuth meal has come to be among radiologists one of the important tests in gastric diagnosis. There are few institutions, even now, equipped with sufficiently high-grade *x*-ray apparatus to permit of obtaining very satisfactory views of the abdominal organs, even when a bismuth meal is used, but within the last three years there have been important observations made by this means by several individuals. Schwarz has recently given a systematic review of the observations which he has been able to make on the behavior of the peristalsis of normal and pathologic stomachs. It seems quite certain that this method of examination will give fairly accurate data which will be of assistance in diagnosis. The advance in anatomic and physiologic knowledge of this region has been great, for we are shown that the descriptions of the stomach based on postmortem findings are far from an accurate description of the living stomach. It has been established that the normal stomach has a persistant tonus which makes it contract on the food which it contains, whether the amount of the latter is large or small. The result of this is that the stomach fills by the constant widening of a column of definite length, rather than by a gradual rise in the horizontal level of its contents. In fact, when the latter condition is found, it is diagnostic of a pathologic dilatation.

Keastle and others have shown that the descriptions of the stomach which are characterized by the positions of the incisura cardiaca and incisura pylorica, etc., are artificial, for these incisuræ or furrows merely represent the advancing peristaltic waves, which are constantly changing. These waves have a fairly definite character, being quite superficial in the body of the stomach and deepening toward the pyloric end, so that when they reach the pylorus they cut off a little segment of the stomach, which diminishes in a pluricentric manner. Thus, there is no real anatomic antrum pylori, but there is a functional new-formed antrum with each constriction wave of the stomach wall. Schwarz claims that by the observation of the depth of the waves and their character definite pathologic conditions of the stomach are recognizable.

For instance, a large perpendicular stomach, with superficial waves and a small antrum, indicates atony, while a similar stomach condition, with a large amount of contents and deep peristaltic waves, indicates obstruction at the pylorus. His observations teach us that we must look on the stomach as on the heart, from the point of view of hypertrophy and compensation. It is possible that this point may lead to the crucial decision as to whether a stenosis has reached a point at which the compensation has failed and surgical intervention must be recommended.

By the bismuth meal we are also able to tell with accuracy the same facts about stasis as we obtain by the use of the stomach-tube. Thus, the normal stomach is empty after a bismuth meal in six hours, while a case with stenosis may show the bismuth for several hours later. If the compensation has reached a certain point, its beginning failure will show by the early appearance of fatigue symptoms. In complete loss of compensation the bismuth meal lies in a half-moon-shaped mass at the bottom of the stomach instead of being held in a perpendicular column.

Hertz and others have shown that it is probable that such a thing as a functional or spasmodic hour-glass stomach exists. Cases are reported which show a typical hour-glass picture at one time which disappears at another. It is quite probable that the appearance of an hour-glass contraction is at times symptomatic of ulcer within the periphery of that contraction, that is, the presence of ulcer in one part of a segment of the stomach stimulates a concentric contraction of that whole segment. It is possible, too, that such a thing as a total gastrospasm exists. Schwarz has seen 2 cases in which a whole stomach was seen to contract quite uniformly. As yet there seems to be no definite method of making a diagnosis of ulcer. The claims of Hemmeter and a few others that the bismuth adheres to an ulcer longer than to other parts of the mucous membrane, and may be thus shown by the radiograph, have not been substantiated. Nevertheless, it is highly probable that increased experience and more perfected technic will, in the future, enable us to give a well-founded opinion by the radiograph alone as to the ordinary deviations from the normal motility. At present we can at least say that it is of assistance in the diagnosis of hour-glass stomach and penetrating ulcer. If the *x*-ray shows that the whole stomach apparently lies high under the ribs and does not come down to its normal level, it should arouse the suspicion that the upper half of an hour-glass stomach is filled with the bismuth which has not had time to percolate through the constriction. In such a case an examination several hours later may show both sacs partially filled (Hertz).

In the diagnosis of penetrating ulcer, that is, an ulcer which has perforated and caused a local cavity, but not a general peritonitis, we must look for an area marked distinctly off from the rest of the stomach and showing a small air-bubble like a miniature "magenblase" (*i. e.*, the normal gas-containing space in the upper portion of the stomach).

Diseases of the Small Intestine.—It is possible that the bismuth meal may be of use in the detection of abnormal duodenal stasis, as in the case of a patient well illustrated by Lane. Since the shadows of the stomach in most instances overlie the shadow of the duodenum, this condition has probably escaped recognition, and it is possible that more accurate attempts made to throw the two shadows apart by oblique pictures will lead to diagnostic use in this field. Recent improvements in the use of stereoscopic pictures of the internal organs may develop this point.

The bismuth meal passes through the small intestine with such rapidity and the coils are so confusing that localization of diseases of the small intestine is not probable. The process of segmentation is so rapid in the human being that it is extremely difficult to observe. In this connection the *x*-ray has brought out one important point, which, although it needs corroboration, is worth mentioning, *i. e.*, Boese and Heyrosky claim that single coils of the small intestine remain in a fairly constant position.

In the diagnosis of Lane's kink or of adhesions in the ileocecal region, Jordan has found that if a large bismuth meal be given, evidences of stasis in the last coil of the ileum can be demonstrated.

Diseases of the Large Intestine.—The use of the bismuth meal has proved of distinct value in this field, owing to the fact that, anatomically, the large intestine is held in a relatively fixed position by its mesenteries, so that its coils do not overlap one another to such an extent as do those of the small intestine. Then, too, the segmentation movements are absent and the fecal material remains for hours at a time in the same position, the peristaltic waves which move the column onward being quite infrequent. In the normal person the haustra can be clearly seen, and the indentations in the bismuth shadow are alleged to be deeper when an irritative hyperperistalsis exists. Surgeons who are interested especially in this field should not fail to read Hertz's book on "Constipation." In making his exhaustive studies of this subject he has used the *x*-ray a great deal, and has found much help in distinguishing the various types of constipation. He points out, for instance, that the behavior of the bismuth meal in the presence of organic stricture is very characteristic and is but rarely simulated by spasmodic stricture. Strangely enough, the food approaches the seat of the lesion in a time even shorter than normal, and the motions of the whole intestine become unusually active.

Although observations of the motions of the large intestine are very valuable, there are many pitfalls which must be avoided in drawing conclusions. The surgeon who is inexperienced in the interpretation of radiographs, when presented with an *x*-ray picture of his constipated patient, is usually at once struck with what appears to be an extremely sharp angulation of the hepatic or splenic flexure. Cases are already being published in which obstinate constipation has been ascribed to these angulations, and in which operations, such as ileocolostomy, have been performed, with the idea of short-circuiting a possible chronic ob-

struction of this nature. Surgeons contemplating such an operation should first make sure by observations with the fluoroscope that there is actually an abnormal delay at these points, for Hertz, who has made many such *x*-ray examinations, has rarely seen delay at these points even when the angulation was apparently very acute. We must remember, too, that since the ascending and descending limb are in different planes, their shadows are more or less superimposed, thus exaggerating the appearance of angulation. In most cases of severe constipation the delay will be found to occur in the pelvic colon, the other landmarks having been passed on schedule time. In such cases ileocolostomy is not indicated. One must be careful, too, not to assume that the upper limit of the bismuth shadow is the anatomic limit of the intestine containing it, for the upper portions of the flexures, for instance, may be empty or full of feces which contain no bismuth, and consequently would cast no shadow. Then, too, the size and shape of the hollow organs depend on the degree of distention and the amount of the material in them, as well as on the tone of their muscle. A pelvic colon may appear to contain a normal amount of fecal matter, and yet, when more distended under pressure by a bismuth enema, it will prove to be abnormally dilated. We must also realize that a mere coating of the surface of the mucous membrane with bismuth throws quite a heavy shadow and gives an appearance as if a considerable quantity of fecal material still remained at a given point, while, in reality, it may merely mean that that particular portion of the mucous membrane was more tenacious, owing to a physiologic or pathologic viscidity of the secretion.

Nevertheless, since many observers agree that the passage of the meal through the alimentary canal is a fairly regular process and proceeds on a pretty definite schedule, we may be fairly confident that great delay in any portion of the schedule indicates distinct local trouble. The following average data given by Hertz are, in the main, in agreement with the observations of others: The food begins to leave the stomach immediately; reaches the cecum in four and a half hours; the hepatic flexure, in six and a half hours; the splenic flexure, in nine hours; the iliac colon, in twenty-eight hours.

Obviously, it is out of place here to discuss this question in further detail, but enough has been said to show that when the medical profession has once realized that pretty accurate data are already at hand to tell us what are the normal times at which the various parts of the intestine should be full or empty, they will recognize that the radiographer can give them great help in showing the part of the intestine in which delay takes place in the individual constipated patient.

Diseases of the Thorax.—The contributions of the *x*-ray to diagnosis in thoracic disease, while not strictly surgical, are of interest in many cases to the surgeon, as well as to the clinician. Even in the early days of the *x*-ray, Francis Williams showed that it was capable of demonstrating early tuberculous lesions in the lung, and now Dunham, in his recent work, corroborates Williams' claims and adds the diagnosis of tuberculous bronchial lymph-nodes. In this connection the student

should review the work of Rieder, in the Fortschritte der Röntgen-strahlen, Band 15, p. 409, with its beautiful illustrations showing thoracic conditions. The surgeon working on the thorax finds the *x*-ray indispensable in demonstrating abscesses of the lung, bronchiectasis, pneumothorax, mediastinal tumors, and metastases in the lungs. Echinococcus cysts of the lung show with great clearness. In hernia of the diaphragm the *x*-ray presents the only means of diagnosis (Scudder).

Diseases of the Kidneys.—In a chapter on this subject illustrations will be found showing the importance of the *x*-ray in this branch of surgery. The injection of collargol in the ureter and renal pelvis makes it possible to demonstrate hydronephrosis in its early stages, as well as strictures and kinks of the renal pelvis and ureter. Radiographs of ureteral catheters impregnated with silver and introduced into abnormal ureters make it possible to demonstrate various unusual positions and reduplications of this passage. Not only is the size and presence of normal kidneys shown by the *x*-ray, but kidneys which are enlarged from the presence of tumors or caseated from old tuberculosis often cast distinct shadows.

Myositis ossificans was formerly considered a rare disease, but cases of its local manifestation following trauma have so frequently been recognized by means of the *x*-ray that every clinic is able to furnish many instances, and now the surgeon, in his effort to find the reason for prolonged stiffness in certain cases of fracture in the neighborhood of joints, thinks at once of the possibility of a local ossification of some muscle adjacent to the joint. This is particularly true in cases of fractures about the elbow, where the brachialis anticus is invaded by osteoblasts.

Many cases of **tabes mesenterica** have been accidentally discovered by the use of the *x*-ray, and where this disease is suspected, the diagnosis may be substantiated.

In **subacromial bursitis** not only may tuberculosis of the head of the humerus be excluded, but in certain cases a deposit of calcareous material is demonstrated by the radiograph beneath the base of the bursa in the supraspinatus tendon.

Certain cases (**hyperostosis cranii**) presenting cerebral symptoms, which formerly were only diagnosed when the trephine was used and met with an extremely thick skull, can now be recognized without operation and a uniform inoperable thickening of the cranium demonstrated.

The use of stereoscopic *x*-ray pictures in cases of **cerebral tumor** bids fair to be of help.

In the diagnosis of **empyema of the accessory sinuses and of deformities of the septum and turbinated bones** the rhinologist turns to the *x*-ray for aid.

In **dentistry** it is daily employed for the detection of unerupted teeth and for foreign bodies producing disease of the antrum.

Therapeutic Uses.—The brief remarks which were made in the earlier chapter (Vol. V., p. 1175) are still true. Improvement has taken place in the application of the *x*-ray to each of these diseases, so that they may be treated with more certainty and less danger.

RADIUM.

The use of radium is still in the stage of experiment. Louis Wickham, of the Radiological Institute of Paris, has recently published a volume on the therapeutic uses of this agent which can be referred to for a special opinion, but at present, as at the last writing, radium has not yet made its place in the domain of surgery.

The remarks on the deleterious effects of the *x*-ray, which were made in Vol. V., p. 1171, are also still applicable. It may be said with even more certainty that the judicious diagnostic use of the Röntgen ray is harmless for the patient, but still dangerous to the radiographer. When repeated exposures of the patient are made for therapeutic purposes or to observe the behavior of the bismuth meal, especial care should be used.

To illustrate the practical help which the *x*-ray may give in the diagnosis of ptosis, the report of a radiographic examination made for me by Dr. Percy Brown is here presented in full, together with reproduction of the plates on which it is founded. The patient was a slight, unmarried woman of twenty-six, who was referred to me for the consideration of operative relief for her dyspepsia and constipation.

Dr. Brown's Report.—An investigation by Röntgen rays of the conditions obtaining in the alimentary tract was embodied in a set of six non-stereoscopic plates, made at various periods in the course of alimentation (Figs. 497–502).

Fig. 497.—An exposure of the stomach, in the prone posture of the patient, four minutes after the ingestion of a bismuth test-meal. Even in this position the stomach sags low, the lowest point of the greater curvature being 7½ cm. below the crests of the ilia. The viscus is apparently atonic and somewhat dilated, the normal peristaltic manifestations being lost. There remains enough of energy, however, to have caused the expulsion of a portion of the anterior portion of the meal.

FIG. 497.

FIG. 498.

Fig. 498.—Eighteen minutes after the ingestion of the meal. Patient standing. The lowest portion of the greater curvature is here 13 cm. below the iliac crests. The evidence of movement here shown is subjective on the part of the patient, and is *not* due to peristaltic action.

Fig. 499.—Four hours after the meal. The major portion of the meal has been ejected into the ileum and thence through the ileocecal valve. This observation

would suggest, therefore, that the stomach has *fair* motor function, in spite of the apparent static abnormality. The motor function of the ileum is due, no doubt, to increased nervous irritability.

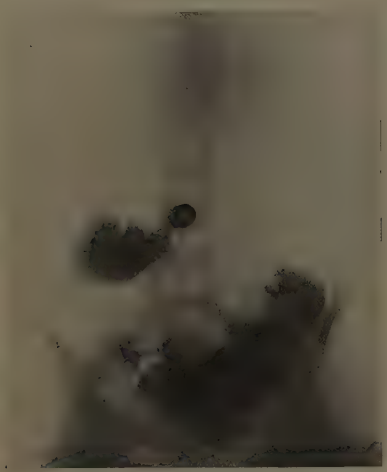

FIG. 499.

FIG. 500.

Fig. 500.—Twenty-three and a half hours after the meal. Standing posture. A portion of the food-mass still in the ileum. The remainder is in the ascending and transverse colons. The profound degree of enteroptosis is clearly revealed. A sharp hepatic kink. The anterior meal has not yet arrived at the splenic flexure.

Fig. 501.—Twenty-eight and a half hours. All the food has not yet passed the ileocecal. Profound enteroptosis at the transverse colon, its mesial portion being 16 cm. below the iliac crests. The splenic flexure is as yet but sparsely filled. The normal contour presented by a well-functioning transverse colon is apparently lost in its efforts to overcome the static handicaps

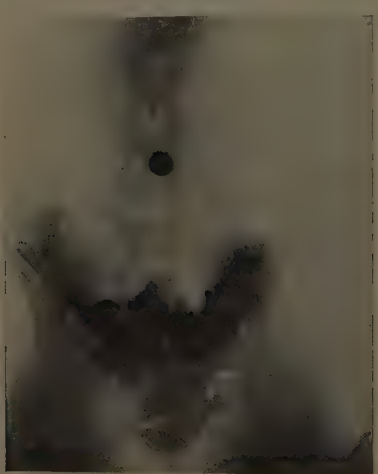

FIG. 501.

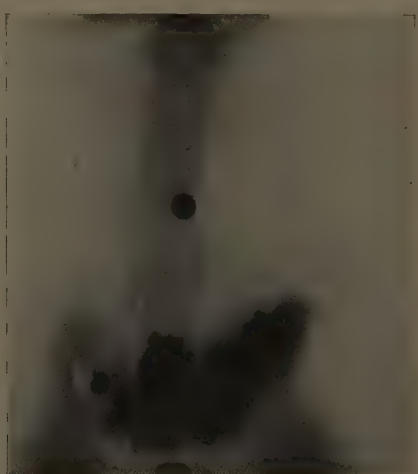

FIG. 502.

Fig. 502.—Thirty-four and three-quarter hours after the meal. Prone position. Sigmoid and rectum filling slowly, but the major portion of the food still occupies the colon. Apparent nervous hyperperistalsis to which the food is subjected in the sigmoid.

Diagnosis.—A description of the above findings leaves hardly necessary a statement of a diagnosis in this case. It is, without doubt, a marked case of gastroptosis, together with the usually attendant elements of atony and dilatation. The mechanical abnormality is also carried into the colon. Here the ptosis is marked and is attended with all the usual manifestations of motor irritability and irritative hyperperistalsis.

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CHAPTER CLV.

THE LEGAL RELATIONS OF THE SURGEON.*

By Hampton L. Carson, Esq.,

Philadelphia.

Four recent cases emphasize the necessity of care in the conduct of operations, and the advisability of supervision by the operator of those details which are generally entrusted to subordinates, but which are imputed in law, on the theory of agency, to the operator himself as a part of his duty. No one wishes to appear as a defendant in a suit for malpractice, and the plaintiff will generally single out the man financially strong, instead of suing nurses and assistants. Even if a Court should decide as a matter of law that the defendant was not liable because of the presence of independent participants, the injury to reputation remains, as well as the annoyance and expense of defending litigation.

In all of these cases it was clear that *somebody had been negligent.* The Court, in the first, second, and third cases, left it to the juries to say who the negligent persons were, and they fastened upon the surgeons. The jury being the tribunal to determine the facts, the Court in each instance refused to disturb the verdicts. In the fourth case, which was a suit against a hospital, while the institution escaped because it was a public charity, yet the right to bring a separate action against the negligent individual remained.

The cases are as follows: J. sued R.,[4] a surgeon, for negligence in operating for appendicitis, particularly in not removing a pad of gauze from the abdominal cavity before the sewing up of the wound. It appeared that several pads had been used and were placed by the assistant. The surgeon *did not remember* how many pads were used. The assistant and the nurses thought that all the pads had been removed, but the fact that a pad was found upon the second operation negatived the contention. The question left to the jury was this: Did the surgeon sew up the wound after the operation and allow a pad to remain in the abdominal cavity? The Court of Appeals held that the real question was not so much who put the pad there, as who allowed it to remain and could it have been removed.

F. sued H.,[2] a surgeon of great reputation, for negligence in allowing a sponge to remain in the body when closing the incision after an operation. The defense was that the hospital internes had handled the sponges and that they were independent of the surgeon. The Court

*Supplementary to Chapter LXXXIV., Vol. V., p. 1180.

refused to charge that it was not negligence in the surgeon to leave the removal to the assistants, and left it to the jury to say whether, under the circumstances, it was not his duty before sewing up the wound to see that the cavity was clear.

S. sued R.[3] for negligence as a surgeon in failing to discover and remove a piece of gauze before closing the incision. The Court followed the ruling in the above case.

G. sued the Sisters of St. Francis[1] (a hospital) for negligence of the attendant in allowing hot water to escape from bottles and scald the patient. The hospital was held immune because a public charity, but the Court declined to pass on the question of individual responsibility, because not properly raised.

As we go to press we note a suit against a surgeon for allowing a pair of forceps to remain in a wound. The rulings of the Court do not appear because the jury on the facts exonerated the surgeon.

The foregoing cases are in striking contrast with the remarks of the Supreme Court of Georgia in Aukridge *vs.* Noble, 114 Ga., 949, where the defense of a surgeon is well stated, to the effect that it is not his duty to count sponges, but the weight of authority is clear that he must at least satisfy himself by examination that the wound can be safely closed.

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4. Ruth *vs.* Johnson (A. D. 1909), 172 Federal Reporter, 191.

CHAPTER CLVI.

THE LABORATORY AS AN AID TO SURGICAL TECHNIC AND TO SURGICAL DIAGNOSIS.[1]

By William M. Late Coplin, M. D.,

Philadelphia.

Since the chapter bearing this title appeared a number of important advances have been made in technic, especially as applied to rapid histologic diagnosis. Wilson[2] wisely advises a small diagnostic laboratory immediately adjoining the operating suite. Such a laboratory, properly furnished with aseptic tables and appliances, may be kept as clean and safe as any operating-room, and when available would greatly facilitate speedy examinations of material, yielding results most useful to the operator and to students who may be following the case.

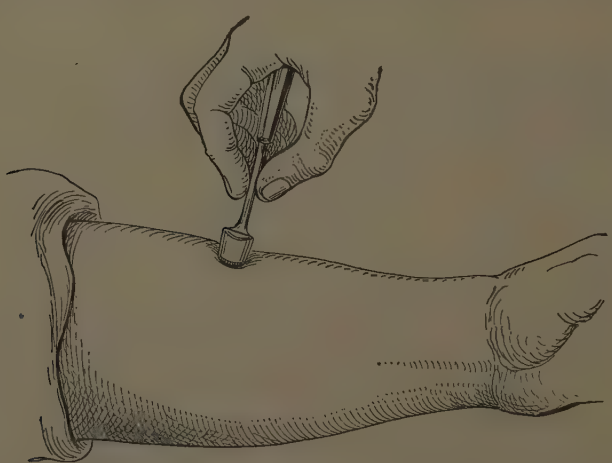


Fig. 503.—Removal of a Fragment of a Superficial Growth with a Skin Punch. (Morrow.)

In addition to the methods for securing specimens, described in the original chapter, the use of freezing and of a punch, as recommended by Morrow,[3] may be recommended. The skin or other exposed surface is frozen and the specimen removed by a trephine-like punch by the method shown in Figs. 503, 504.

[1] Supplementary to Chapter LXXXV., Vol. V., p. 1198.

[2] St. Paul Med. Jour., May, 1910; also Collected Papers by the Staff of St. Mary's Hospital, Rochester, Minn., 1911, p. 545.

[3] Diagnostic and Therapeutic Technic, p. 229.

With regard to the use of frozen sections and rapid diagnosis at the time of operation, Wilson has reviewed his own technic and that of Strouse.[1]

Pieces of fresh tissue (10 mm. square and 2 mm. in thickness) are frozen in a syrupy dextrin solution and cut in sections 5 to 10 microns in thickness. Using the tip of a finger, the sections are removed from the knife, allowed to thaw, and are unrolled in a 1 per cent. aqueous solution of sodium chlorid; a camel's-hair brush is useful in straightening out the sections. They are then stained for from ten to twenty seconds in Unna's polychrome methylene-blue, washed quickly in salt solution, and mounted in Brun's medium. Brun's medium is prepared by mixing 10 parts of glycerin, 40 parts of glucose, 140 parts of distilled water, and then adding 10 parts of spirit of camphor; the precipitated camphor is removed by filtration. The advantage of Brun's medium is that it preserves the color of preparations stained with anilin dyes. Long expe-

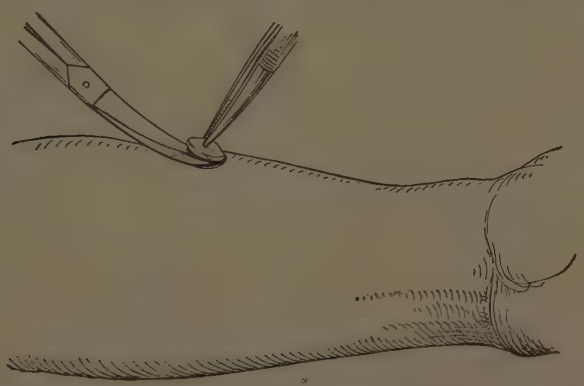


FIG. 504.—REMOVAL OF A FRAGMENT OF A SUPERFICIAL GROWTH WITH A SKIN PUNCH: SECOND STEP. CUTTING LOOSE THE BASE OF THE SECTION. (MORROW.)

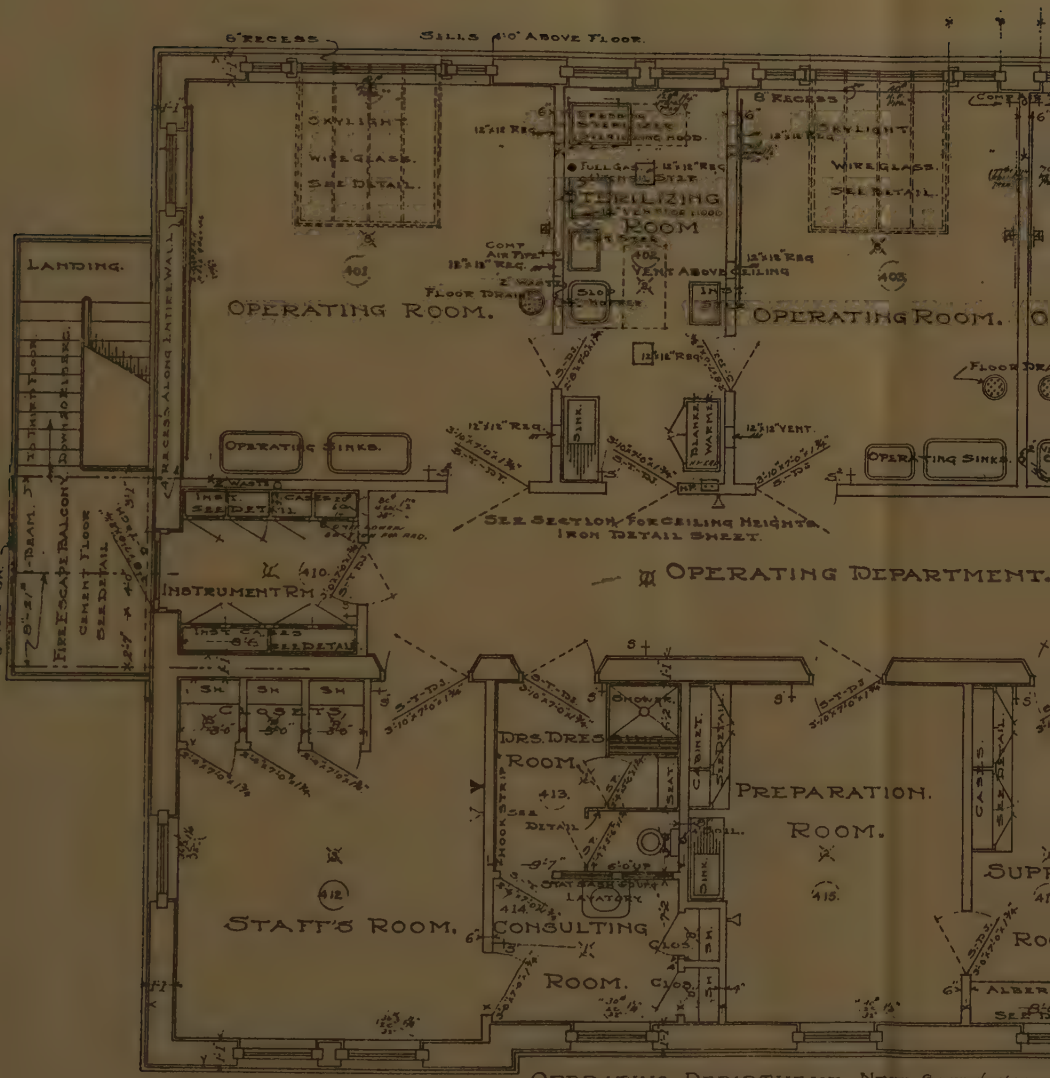
rience with thionin enables me to endorse Strouse's method of staining. The dye is prepared by mixing equal parts of a saturated aqueous solution of Grubler's thionin and a 2 per cent. aqueous solution of phenol; for a time the mixture improves with age, but later it usually deteriorates. Carbolic acid acts as a mordant and enhances the polychrome action of the stain. The spread-out section is floated on a slide, the excess of fluid removed, a drop of thionin solution applied, and a cover-glass at once adjusted in position. Any excess of fluid may be removed by blotting the edges of the cover; the preparation is now ready for examination. If the piece of tissue has been partly fixed in a 10 per cent. aqueous solution of formalin, sectioning is facilitated and the stain is equally efficacious.

In the previous chapter frozen sections for rapid diagnosis were not fully endorsed. In experienced hands it no doubt possesses a most useful field, but cannot, however, be removed from the danger incident

[1] Jour. Amer. Med. Assoc., May 14, 1910, p. 1614.

to random sampling, even with most careful tissue selection, and does not possess the advantage of serial sections possible by the paraffin method only. Bloodgood[1] observes that "In my experience, after one has had a sufficient training the diagnosis from the gross appearance is easier and undoubtedly quicker and, in many cases, more certain than from a rapid frozen section." Notwithstanding my personal objection to diagnosis based upon rapid frozen sections, there can be no doubt that extended familiarity with the technic and a large experience in examination of specimens prepared in this way may yield corroborative data in doubtful cases. McCarty[2] believes that frozen sections stained with polychrome methylene-blue are better than paraffin or celloidin sections. Even admitting that the sections are equally good, the advantage incident to examination of many sections, often from different areas, lies with the slower paraffin method.

[1] Jour. Amer. Med. Assoc., Oct. 30, 1909, p. 1475; see also "Discussion," p. 478.
[2] Ibid., p. 1478.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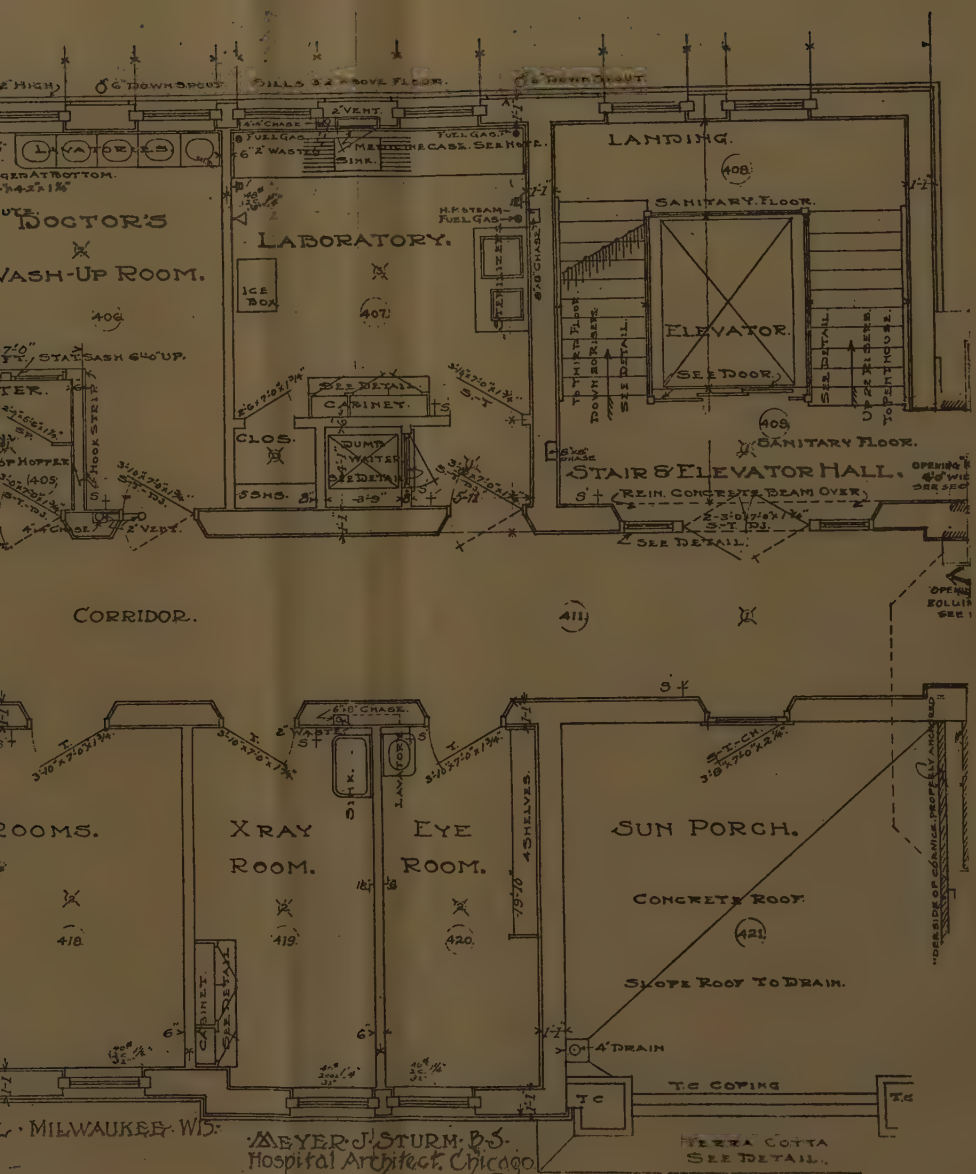
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4" DRAIN
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T.C.
TERRA COTTA
SEE DETAIL.
MEYER J. STURM, B.S.
Hospital Architect, Chicago
MILWAUKEE, WIS.

CHAPTER CLVII.

THE SURGICAL ORGANIZATION OF A HOSPITAL.[1]

By A. J. Ochsner, M.D.,

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OPERATING DEPARTMENT FOR HOSPITALS WITH 200 TO 500 BEDS.

During the past few years an enormous number of new hospitals have been constructed, and many of the older hospitals have added new wings, usually containing modern operating-rooms. There has developed a marked tendency toward securing efficiency at a reasonable cost of construction and with the possibility of conducting an efficient service at a reasonable cost of maintenance, with the view of conserving the time and energy of the surgeon and his staff and that of the surgical nurses. This tendency has resulted in almost daily requests for suggestions concerning the planning of operating floors for surgical wings. The plan which was in vogue a number of years ago, of spending large sums of money for the construction of entire buildings for the housing of operating-rooms, seems to have been discarded generally, and instead of this the north end of the top floor of the surgical wing has usually been chosen for the construction of the operating department. In this manner it is possible to secure equal facilities at from 15 to 40 per cent. of the cost of constructing operating departments according to the former plan of having a special pavilion for this purpose.

In order to facilitate the study of this plan for a hospital somewhat larger than that illustrated on p. 1219, Vol. V., the accompanying illustration (Plate IX.), representing the operating floor of a hospital constructed during the past year, may serve admirably, because it provides ideal facilities for an enormous amount of surgical work, and still it is so concentrated that the cost of construction and the cost of maintenance are exceedingly small. In this case the department has been placed on the top floor of a new wing which has been added to an old hospital. The three operating-rooms are provided with an enormous amount of north light coming from windows 16 feet wide, reaching from a point 3 feet from the floor to the ceiling, and then continuing in the form of sky-lights for a distance of 16 feet more. The skylights are so steep that the sun cannot enter the room, because these, as well as the windows, face the north.

The sterilizing room is conveniently placed between two of the operating-rooms. A large room on the opposite side of the hall serves as a preparation room for the patients and for anesthesia and dressing room.

[1] Supplementary to Chapter LXXXVI., Vol. V., p. 1211.

An important feature of this plan is found in the recovery rooms, which make it possible to keep patients recently operated on entirely away from those formerly operated upon, and those who are to be operated upon in the future until they have completely recovered from the anesthesia and the postoperative pain. This increases the comfort of all, and improves the service enormously. If it is desired to have patients recover from the anesthesia in the open air, they may be placed in the sun room for this period.

The pathologic laboratory with a north light is conveniently placed, also the room for washing before entering the operating-room, and the facilities for taking a shower-bath after the operation are most satisfactory.

The special room for *x*-ray examinations and the dark room for ophthalmoscopic and laryngoscopic examinations have been found most satisfactory in this institution.

It will, of course, be necessary to change and vary many details in each individual case, but it seems quite worth while to have in mind an individual plan which in the element of efficiency has been developed to such a marked extent, and in which it has been tested practically and found satisfactory.

It may be well to direct special attention to the fact that all doors through which surgeons or nurses have to pass in their work, in fact, all doors except those of closets, lockers, and instrument cases, of the type that swing both ways, so that one can back through any door without touching it with the hands in order to open or close it.

The floors should be constructed of some impermeable substance, because this facilitates cleaning. Wooden floors are, of course, equally safe, but, in the long run, much less economical. White tile should be avoided, because in an operating department in which much work is being done the white tile floor looks repulsive except just after it has been polished and before the next operation is begun. Flake mosaic or Terrazzo, although theoretically less desirable, is much to be preferred in practice.

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